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BUTTERFLY & OTHER INVERTEBRATES CLUB INC.

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Aims of the organisation

- To promote the importance of invertebrates in the environment
- To hold information meetings and organise excursions around the theme of invertebrates
- To promote the conservation of the invertebrate habitat and encourage the growing of butterfly host plants
- To promote research into invertebrates
- To encourage the construction of invertebrate friendly habitats in urban areas

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Membership

Annual fees are $30 for families, individuals, schools, organisations.
Banking details are BSB: **484-799**, Account No: **001227191**, Account name: **BOIC**,
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General meetings

Quarterly meetings, are held with guest speakers and to organise BOIC events.

Deadlines for publishing in *Metamorphosis Australia*

If you wish to submit an item for the publication the following deadlines apply:
1 February (March Issue), 1 August (September Issue).

All articles should be submitted directly to the Editorial Committee: secretaryboic@gmail.com. This publication has been produced with the co-operation and combined efforts of the editorial committee, individual contributors, artists and photographers. All materials in *Metamorphosis Australia* are copyright of the authors, artists, photographers and the BOIC.

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This publication seeks to be as scientifically accurate as possible. The views opinions and observations expressed are those of the authors. It is a platform for people, both amateur and professional, to share information, news and images of butterflies and other invertebrates. The submitted manuscripts are reviewed with editorial changes suggested if applicable. The editorial committee reserves the right to refuse to publish matter that it deems unsuitable for publication.

Cover image: Photograph courtesy of Aub Podlich, Robber Fly,
***Ommatius mackayi* Ricardo**

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Hello from the President

Welcome to our bumper issue of *Metamorphosis Australia*, issue No 102. You will have noticed that the issue date has been delayed due to the swell of articles that have been submitted and the significant time required by the new editorial panel to deal with such a large number of submitted manuscripts. The other good news is that from 2022 onwards the BOIC committee has agreed that publication months will be in March and September. This will tend to avoid the production of a magazine leading up to the Christmas period. Within this issue we have three reports of seminars delivered at two club general meetings (May and November 2021), and at the Biodiversity Seminar series sponsored by the BCC, three book reviews, more news on *Acraea terpsicore* in northern Queensland, plus some interesting articles on a variety of other invertebrate groups, moths, native bees, even isopods. In addition, you will find the results of the butterfly survey at Boondall Wetlands, a club initiative supporting Brisbane's Big Butterfly Count.

I trust that you will not be disappointed in the bumper issue, and at this point the committee would like to pay tribute to our hard-working previous president, no introductions necessary, Ross Kendall, who has received life membership to the club for his tireless efforts over a collective 15-year period. Many thanks Ross and well done! The club was blessed to have had Ross steering the club always in the right direction for all those years.

At the general meeting held on the 13 November it was approved that the renewal date for membership fees will fall on the 1st January each year. The enclosed letter explains the renewal process for each individual member.

Finally, congratulations to BOIC member Aub Podlich for the wonderful image of the Robber Fly *Ommatius mackayi*, chosen for the cover image of issue No 102.

Kindest regards

Trevor

The butterflies of the Torres Strait islands: a fauna in review

(Transcript of presentation at the BOIC General Meeting, Karawatha Forest Discovery Centre, 13 November 2021)

Trevor A. Lambkin

This work is dedicated to the traditional custodians of the Torres Strait islands on which they work and live, and thus I pay respect to Elders past, present and emerging

The Torres Strait lies in the far north of Australia and is a 150 km wide shallow seawater gap between mainland Queensland and Papua New Guinea (PNG), with a total of approximately 280 islands, islets and cays (Fig. 1). The region has a tropical monsoonal climate that receives the bulk of its rain during the first three months of the year. The islands of Torres Strait vary in their geology, topography and floral composition, and can broadly be grouped into four physiographic types: granitic and basaltic soils, mud and sand. Butterflies were first collected in Torres Strait on Erub Island during 1843–1845, but since then have been collected on all inhabited islands and several uninhabited islands mainly since the 1980s. The data from these collections are far from complete and very fragmented, and this work has gathered these data. From 38 islands, islets and cays of Torres Strait 227 butterfly taxa are here recorded (Figs 2, 3). This study (Fig. 4) constitutes an inimitable piece of work, as it is a comprehensive assessment of a single animal group (i.e. the butterflies), occurring on several Australian islands where an important and unique culture of people resides, i.e. the people of the Torres Strait islands (Fig. 5).

Analyses of these island data indicated that the greatest influence on an island's butterfly species composition and richness was its physiography, especially islands with granitic and basaltic soils, which are the geologically oldest in origin. Thus, there was a positive linear relationship between species richness and larger granitic, or basaltic islands. The butterfly faunas of Dauan (granitic) (Fig. 6), Saibai (mud) (Fig. 7), Erub (basaltic) and Mer (basaltic) (Fig. 8) Islands suggest a distinctly PNG provenance, whereas the granitic islands in the southwest of the strait, Moa and around Waiben (Thursday Island), are more Australian. Moreover, predictor variables (as per island biogeography theory) of island size and distance from the two mainlands showed less obvious correlation. Thus, for almost all Torres Strait butterfly species, island physiography provides the best species richness predictor; secondarily an island's size. The granitic and oldest islands, richest in butterfly species are Dauan, with a low dissimilarity to the PNG butterfly fauna, and Moa Island and the island group around Waiben Island, which have low dissimilarity to the butterfly fauna of Queensland. The butterfly fauna of the two basaltic islands in the east of the strait, Erub and Mer have a low dissimilarity to the butterfly fauna of PNG. All other islands, mostly spread across the central Torres Strait zone, are typical oceanic coral cays with depauperate butterfly and floral faunas, quite dissimilar to the richer PNG and Queensland faunas. The mainly mud-built islands of Boigu and Saibai are richer in butterfly species than the coral cay islands. The 91 butterfly taxa recorded from Saibai suggest that the island may be an extension of the adjacent swampy PNG lowlands (Fig. 9) rather than a mud deposit. The five islands with the highest richness in butterfly taxa were Dauan (144 recorded taxa), Waiben (126), Moa (116), Mer (103) and Erub (95). Islands with the highest numbers of butterfly taxa do not necessarily have the highest floral diversity and it appears that specific plant species' communities or compositions, rather than floral richness *per se*, may determine butterfly richness.

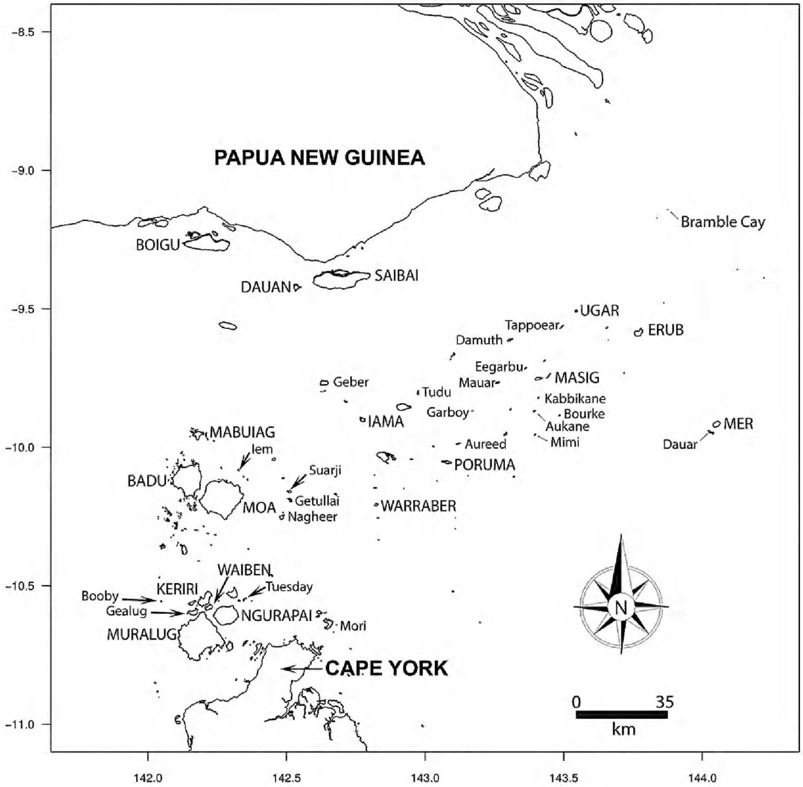
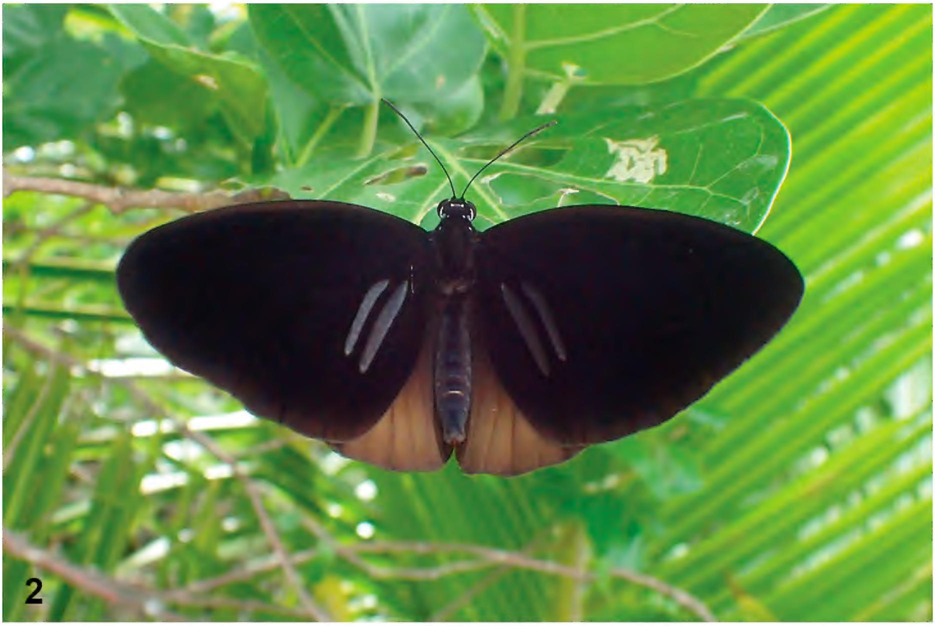


Fig. 1. Torres Strait, Queensland. All islands indicated by name have butterfly collection records, except Bramble Cay. Island names in upper case are inhabited.



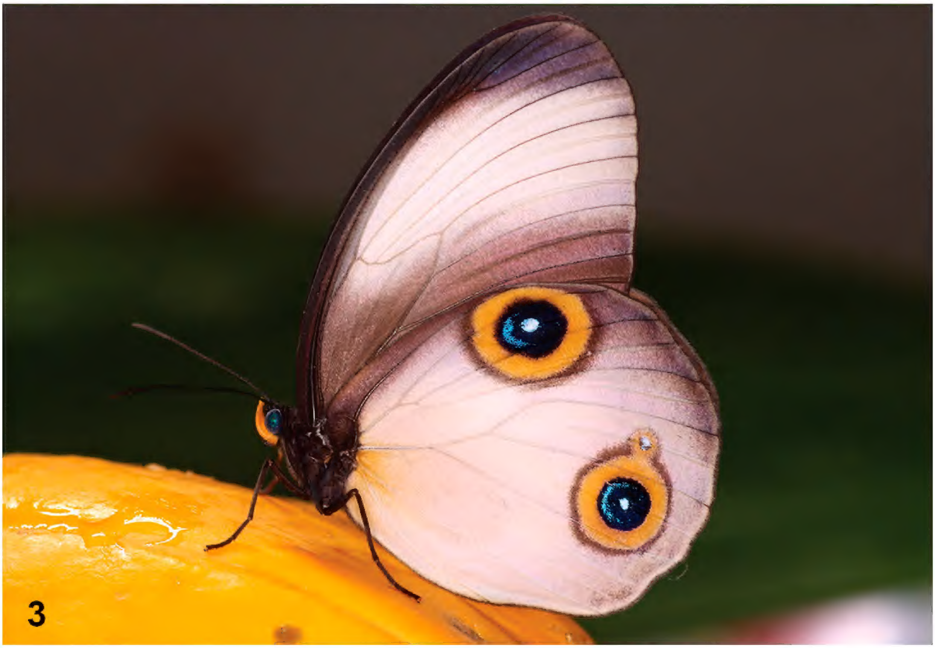
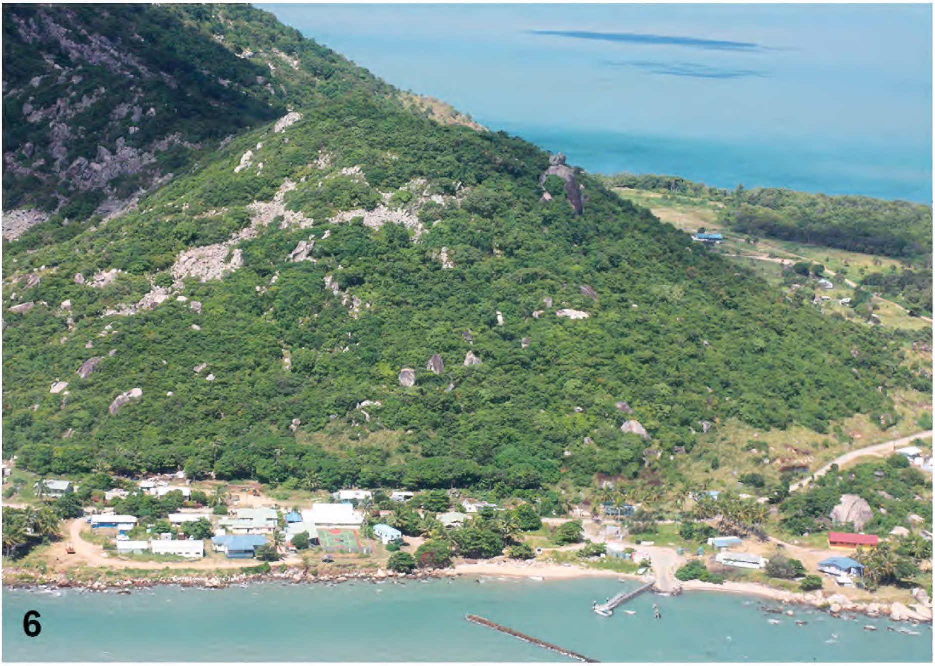


Fig. 2. Two-brand crow butterfly (*Euploea doleschallii*), **Fig. 3.** Pearl owl butterfly (*Taenaris artemis*)

Fig. 4. The author on Dauan Is., **Fig. 5.** Maluwap Nona from Mer Is. (with permission)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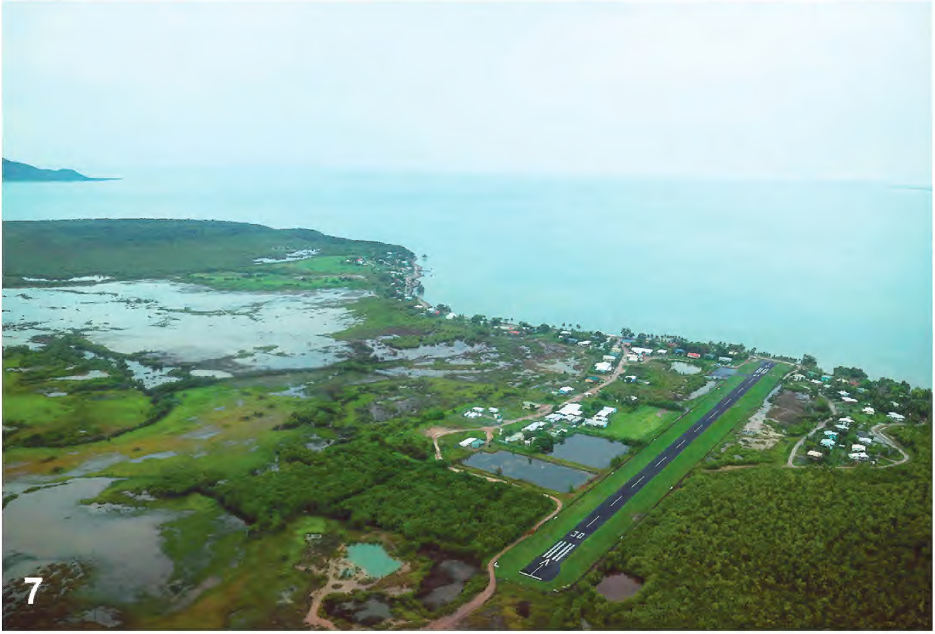
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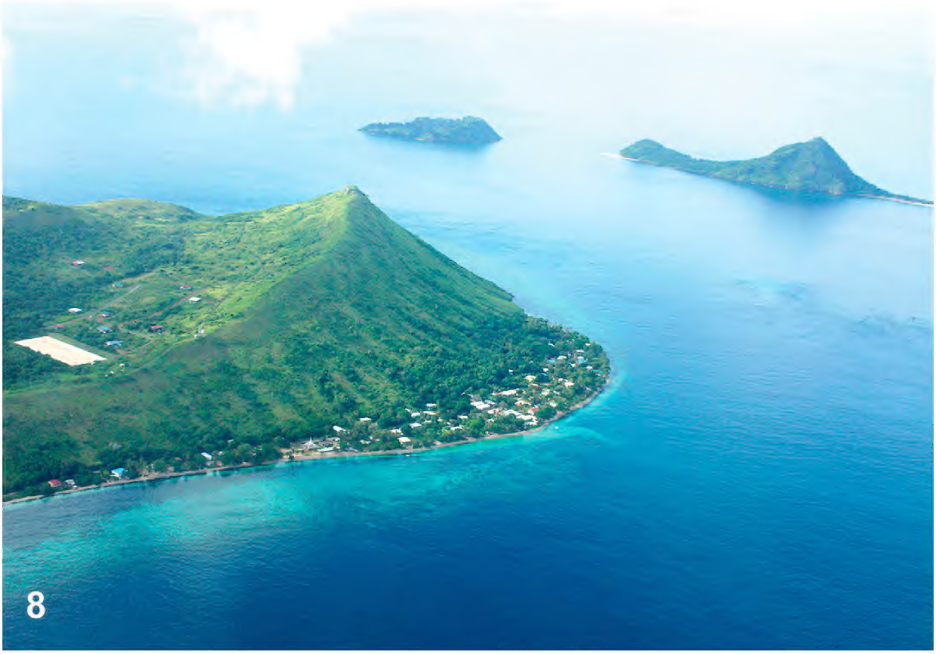
Fig. 6. Dauan Is., **Fig. 7.** Saibai Is.



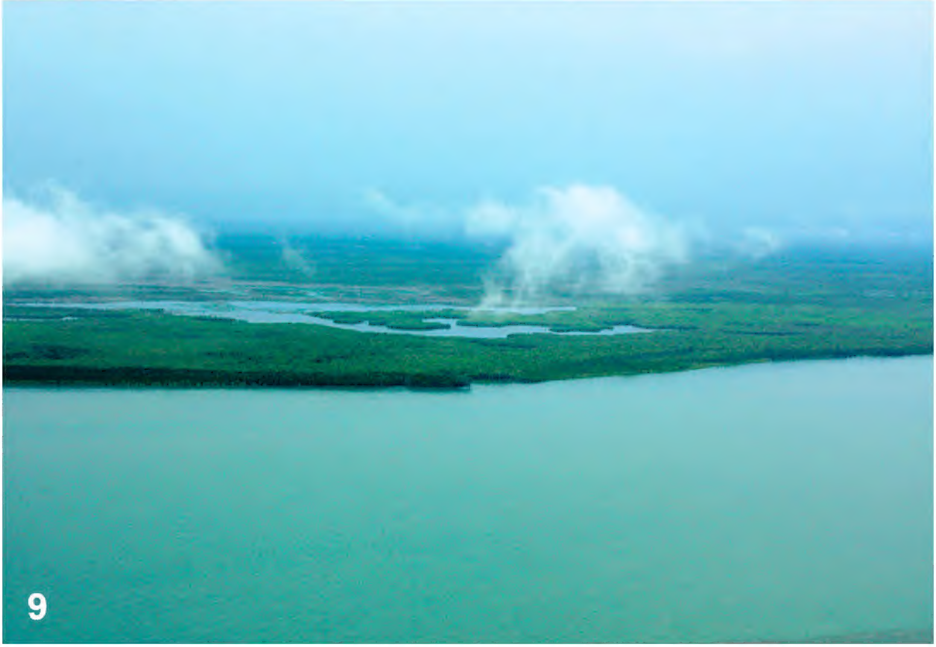


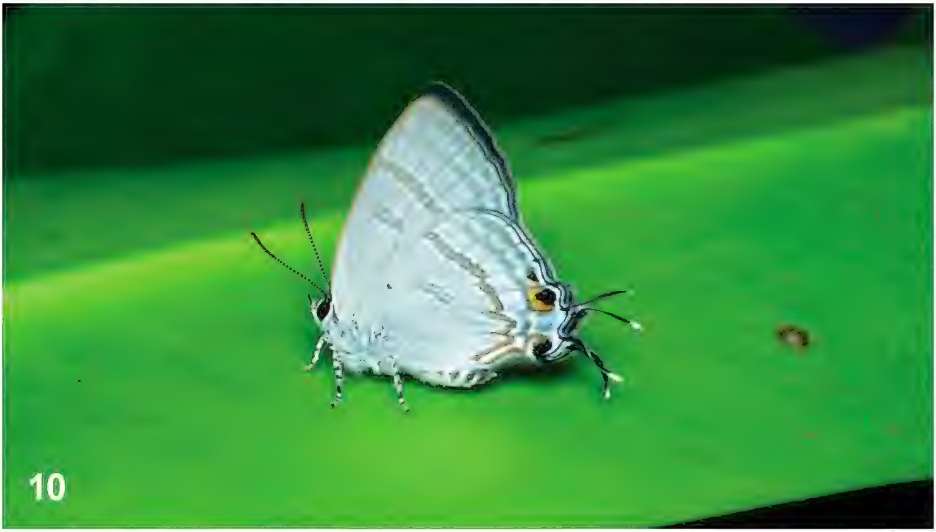
Fig. 8. Mer Is., **Fig. 9.** Southern Papua New Guinea lowlands (Fly Platform)

Percent butterfly vagrancy was estimated for four islands, Dauan (19%), Erub (25%), Mer (22%) and Waiben (22%); where vagrants were considered to be ephemeral species that either did not breed on the island, or perhaps did so for only a limited period prior to their extinction. Vagrant species' compositions suggested that, within Torres Strait, these arrive from the south and north. Percent vagrancy estimations were unrelated to the islands' distance (i.e. their remoteness) from the nearest land mass. Based on these estimations, it appears that significant butterfly numbers regularly fly out over Torres Strait to arrive on islands, even those considered remote such as Mer Island. Thus, it seems likely that other vagile insects (e.g. pests), may frequently cross Torres Strait, especially from a northern direction during the monsoonal season. The appreciable numbers of vagrant arrivals estimated for Erub and Mer Islands and their surprisingly rich faunas suggest that these are PNG in origin, despite the islands' relatively small sizes and perceived isolation.

Additionally, detailed collation of butterfly collecting and observational data from the Torres Strait islands has allowed comprehensive checklists and distribution maps to be constructed and combined with the analyses provide a better understanding of biogeographical relationships between the butterfly faunas of these islands with Papua New Guinea (PNG) to the north, and Australia (Cape York, Queensland) to the south. This information and these analyses will assist whenever subsequent conservation measures are required. Surveys of poorly explored islands will likely reveal additional species records to further improve our understanding of the biogeography and conservation status of Torres Strait butterflies.

Finally, future threats likely to impact Torres Strait butterflies include climate change induced sea-level rises and human land use effects, especially fire threats and weed invasion. The inhabited Torres Strait islands most likely to be impacted by sea-level rises are Masig, Poruma and Warraber (coral cays), Iama (low granite), and Boigu and Saibai (sedimentary mud), where the most climate change susceptible habitats are ocean strands and mangroves. Butterfly taxa that are not recorded from the Australian mainland but are known from Torres Strait number 69. Of these, 17, including an endemic Torres Strait species, *Hypolycaena litoralis* Lambkin *et al.*, 2005 (Figs 10, 11), are limited to island fringing mangrove, lowland areas and swampy habitats. Therefore, the northwestern end of Dauan, and all of Saibai and Boigu Islands, are at the highest risk of losing several of these habitats (and the 17 taxa associated with them) by sea-level rises and anthropogenic influences, especially weed invasion and fire threat.

In summary, the results of this study indicated that even islands in Torres Strait that may be considered quite 'remote' were likely not far enough from the two mainlands to inhibit immigration of continental butterflies. Moreover, the Torres Strait islands, which seemed to contradict classic island biogeography theory, are likely not a suitable model system for quantitatively predicting island biogeography, due to their relative closeness to the mainlands of Queensland and PNG; rather, geological composition and size of islands could be used in most cases as a crude measure to predict butterfly species composition and species richness on Torres Strait islands.



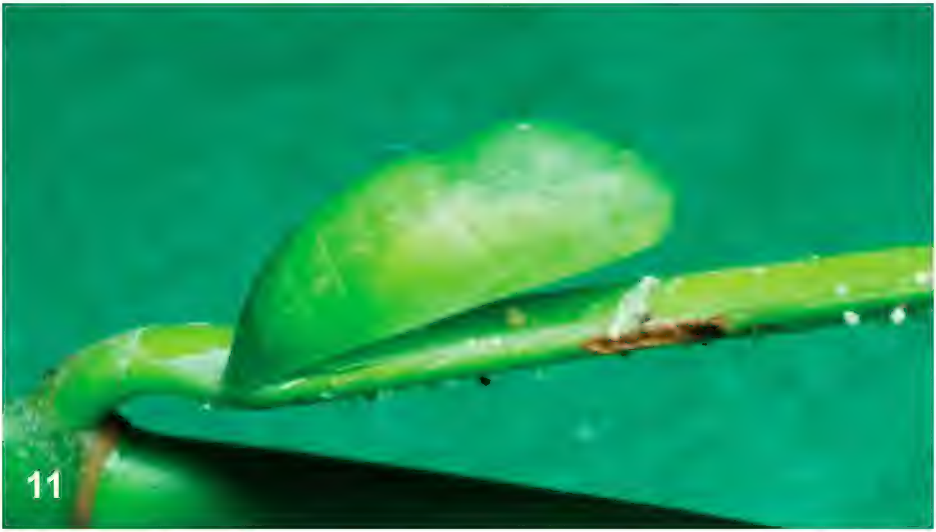


Fig. 10. Mangrove flash (*Hypolycaena litoralis*), adult female butterfly, **Fig. 11.** Mangrove flash (*Hypolycaena litoralis*), pupa

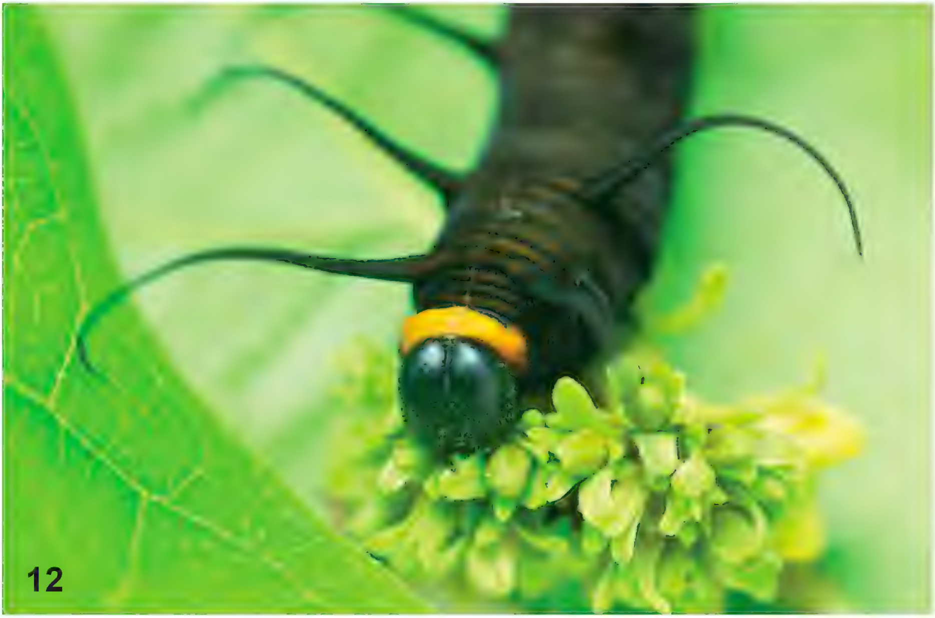


Fig. 12. *Euploea batesii batesii*, final instar larva (Mer Is.)

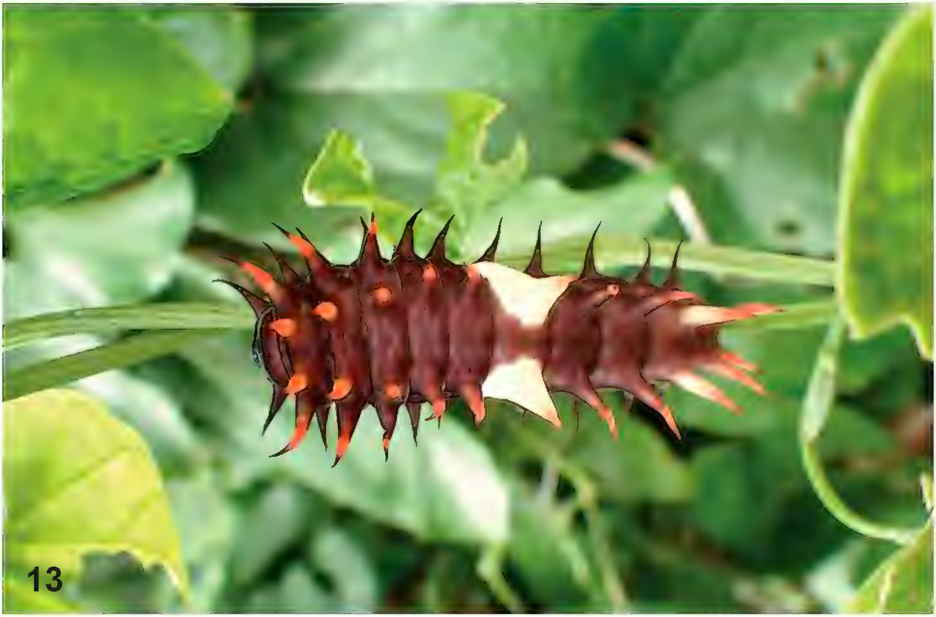


Fig. 13. *Ornithoptera priamus poseidon*, late instar larva (Dauan Is.)

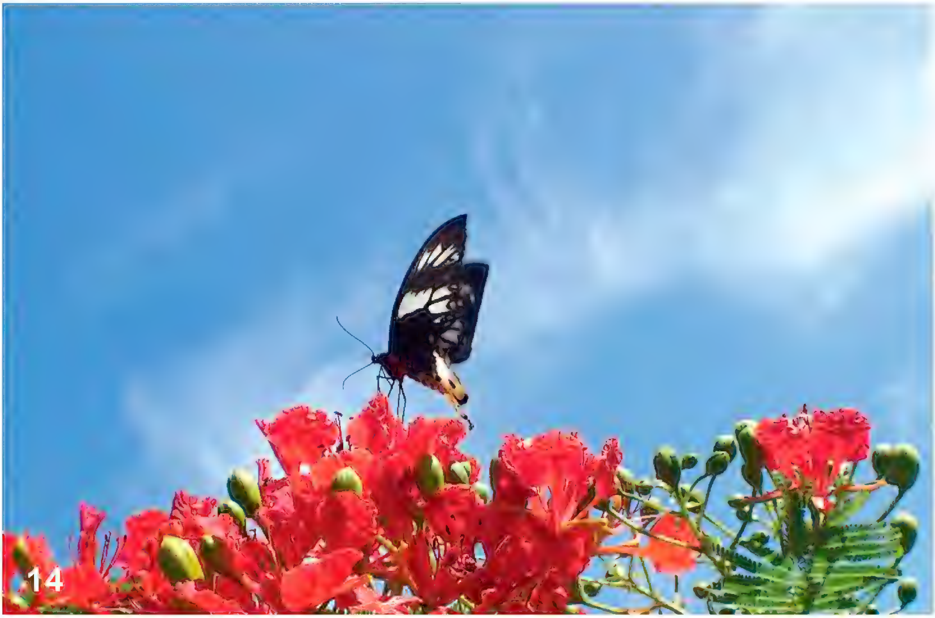


Fig. 14. *Ornithoptera priamus poseidon*, female feeding on *Delonix regia* blossom (Dauan Is.)

Fig. 15. Main jetty, Waiben (=Thursday) Is.

Observations of native bees and native plants

Jenny Thynne

Introduction

At least 56 different Australian native bee species have been observed in our 1000 square metre yard in suburban Sunnybank in Brisbane. This includes four of the five Australian bee families: Colletidae, Halictidae, Megachilidae and Apidae. Stenotritidae is the exception, the vast majority of sightings of which have been in Western Australia.

My fascination with our native bees began after I rescued one of Australia's largest bees from a birdbath in 2011. It was a 25 mm long female Great Carpenter Bee – *Xylocopa (Koptortosoma) lieftincki* (Fig. 1). This started me off on a wonderful journey of discovery as I observed, photographed and researched our native bees. My interest in macro photography developed further because of the amazing detail of the bees and their behaviour it revealed.

It surprised me to learn that the vast majority of Australia's native bees are solitary or semi-social, and don't make honey or live in hives, unlike the tiny sugarbag bees of which there are at least 10 species. There are more than 1,600 Australian native bee species, ranging in size from 2 mm to 26 mm. Many are yet to be identified and described, and new species are still being discovered.

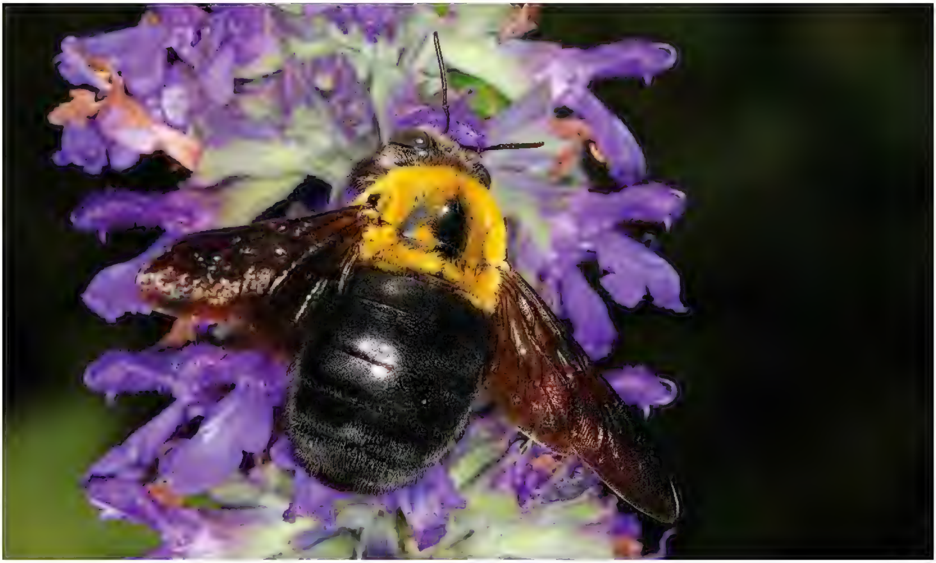


Fig. 1. Great Carpenter Bee (*Xylocopa (Koptortosoma) lieftincki*) on Salvia

I've found that a range of factors influence the presence of native bees: climate, soil, surrounding vegetation, seasonal variations, availability of flowers for nectar and pollen, and suitable nesting sites.

Native bees have a variety of nesting habits. Some burrow in soil, some in mortar between house bricks, some nest in bamboo canes, some excavate in dead wood and plants, some live in tree hollows or in the flower stalks of grass trees (*Xanthorrhoea* spp.); some, such as species in the family Megachilidae, even use bits of leaf to line nests in hollows in wood or soil. We have a number of bee hotels of varying design which are regularly occupied by a number of native bee species.

Amegilla (Family Apidae)

Some of Australia's most charismatic native bees belong to the genus *Amegilla*. We've had four species identified here so far. Three belong to the sub-genus *Zonamegilla* (Blue-Banded Bees) and one to the subgenus *Asarapoda* (Teddy Bear Bees). We've been fortunate enough to have females nesting in the yard, and males and some females roosting at night in secluded spots.

I don't see many Teddy Bear Bees in a season, perhaps three or four, but once I was lucky enough to see a pair mating on a Buddleia. The female was moving around, feeding on each flower with the male on her back (Fig. 2).

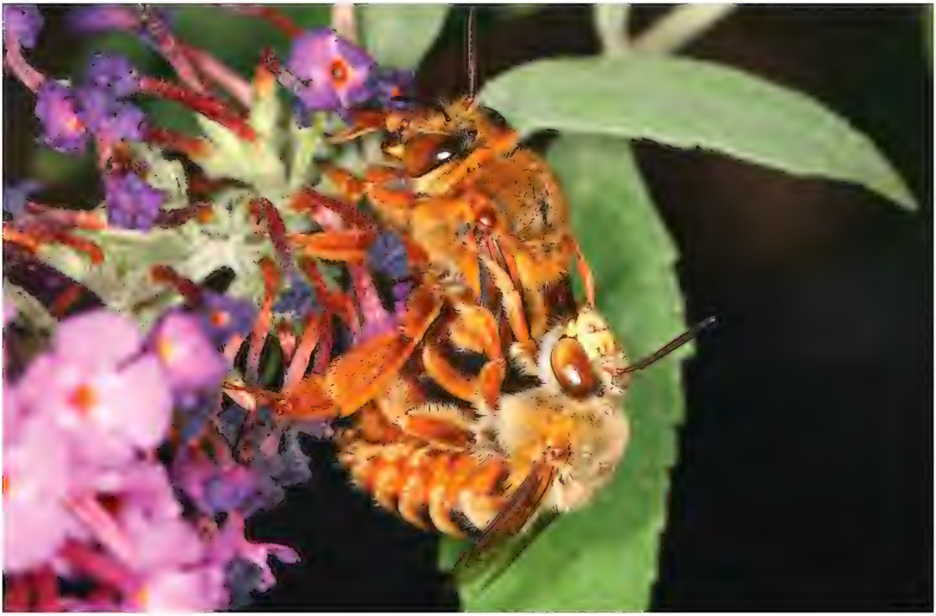


Fig. 2. Mating Teddy Bear Bees on Buddleia

Once the Amegilla season begins, usually mid-October in our yard, I go out most nights to monitor the number of roosting bees. One night three years ago I found a total of 50 *A. cingulata* males roosting on two narrow twigs, but 25 is about the average maximum we see roosting most years (Fig. 3).

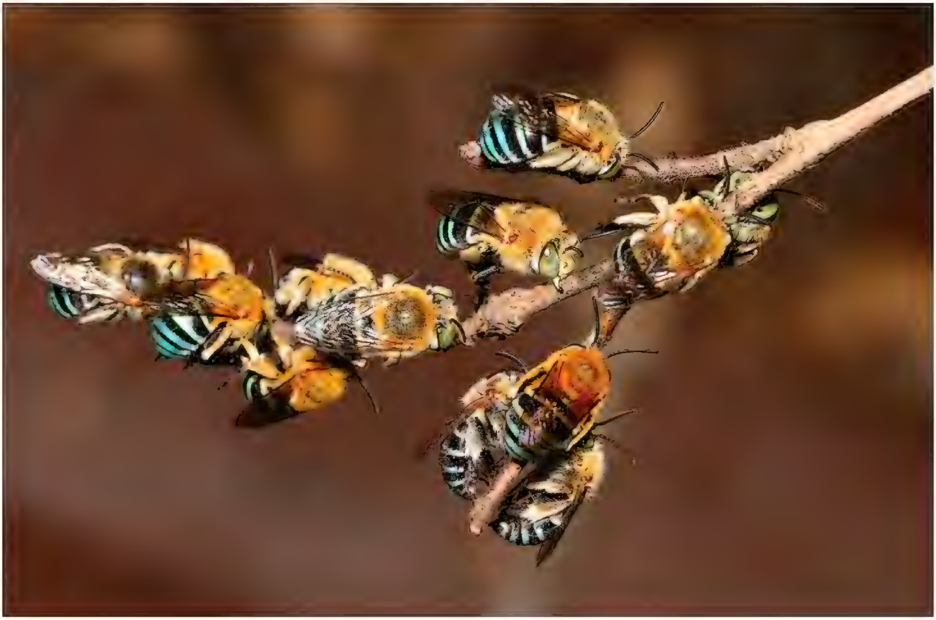


Fig. 3. Roosting Amegillas

Last season I got a surprise one night when I went out to check on our roosting Blue-Banded Bees. Usually, we get a large cluster of males on one stem and one or two females roosting nearby singly. When I looked through the macro lens, I could see that all eight on one twig were females! That same night there were only two males roosting. Usually, females overnight in their nests, so this behaviour was quite unusual. As the nights passed the number of males roosting increased and the group of females gradually reduced, eventually disappearing as they presumably made nests.

There are two easy ways to tell the difference between the sexes of Blue-Banded bees: females have four blue stripes on the abdomen and distinctive black markings on the face, and males have five blue stripes.

Amegillas, along with the genus *Xylocopa*, and some species in the Colletidae and Halictidae families, are buzz pollinators. The females curve their bodies around the anthers of a flower, rapidly vibrate their flight muscles, and the pollen is shaken out through the pores of the anthers and onto the bee's body. You can hear the larger bees buzzing loudly as they perform this feat.

Another interesting behaviour I've observed with Amegillas is nectar robbing (Fig. 4). The bees use their proboscis to pierce the base of the corolla where the nectary is located if the tube of the corolla is too narrow for them to get inside. They then draw up the nectar.

Meroglossa itamuca (Family Colletidae)

Back in 2016 I noticed a small black bee with yellow markings, about 8–9 mm long, emerging from a bamboo garden stake. It was identified as *Meroglossa itamuca* because of the distinctive markings on the face of the males (Fig. 5).

I started looking closely at other plant stakes and noticed little faces peering out at me. I've been able to watch these bees closely now for five years. I've seen up to six new males emerging from the one nest hole, females pushing them out of the hole. Other behaviour observed was two females removing rain water from one of the stakes, drop by drop. They must have swallowed the water, as they each secreted it from the tip of their abdomen onto the top of the stake. Over the period of at least an hour and a half they continued this process.

At the moment we have at least 24 of these bamboo stakes occupied by the bees, as well as the hollow stem of an old salvia. The stakes are occupied by females the entire year, and they are active even in winter. It's not known how long these bees live for. The pots containing the stakes are placed where they get winter sunshine, but are under cover. These little bees have also taken up residence in one of my bee hotels which is a wooden block with holes of varying diameters drilled in it.

Female *M. itamuca* bees work cooperatively, cleaning out the nest after the new bees have emerged (Fig. 6). Some of the male bees return to the stake after cleaning and have been observed staying in the nest hole for up to five weeks.

Plants

Originally, I thought of using only native plant species to attract native bees, however because of my suburban location, lack of room and also the seasonal variations in flowering times, I've found that adding exotics, including vegetable plants increases the likelihood of visits by native bees, especially if you have plants in the Solanum family such as tomatoes, eggplants and chillies which Blue-banded bees and other buzz pollinators visit. Basic staples in the small garden for attracting a range of native bees are perennial basils, lavenders and salvias, especially deep blue ones such as "Indigo Spires", "Mystic Spires" and "Anthony Parker". Perennial basil has a very long life and flowering period, and is easy to propagate as are the native plectranthus species.

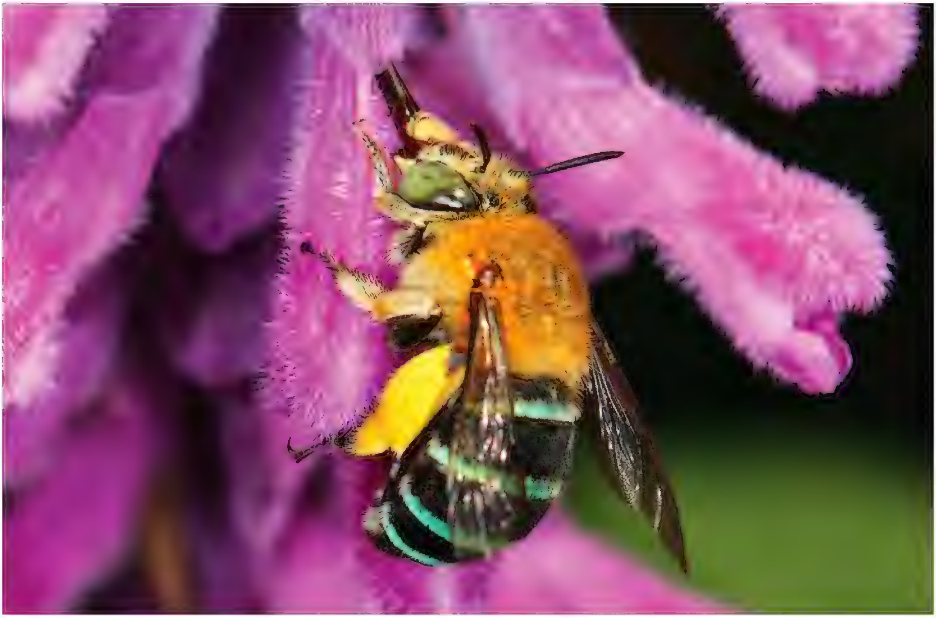


Fig. 4. *Amegilla cingulata* robbing nectar from a Salvia

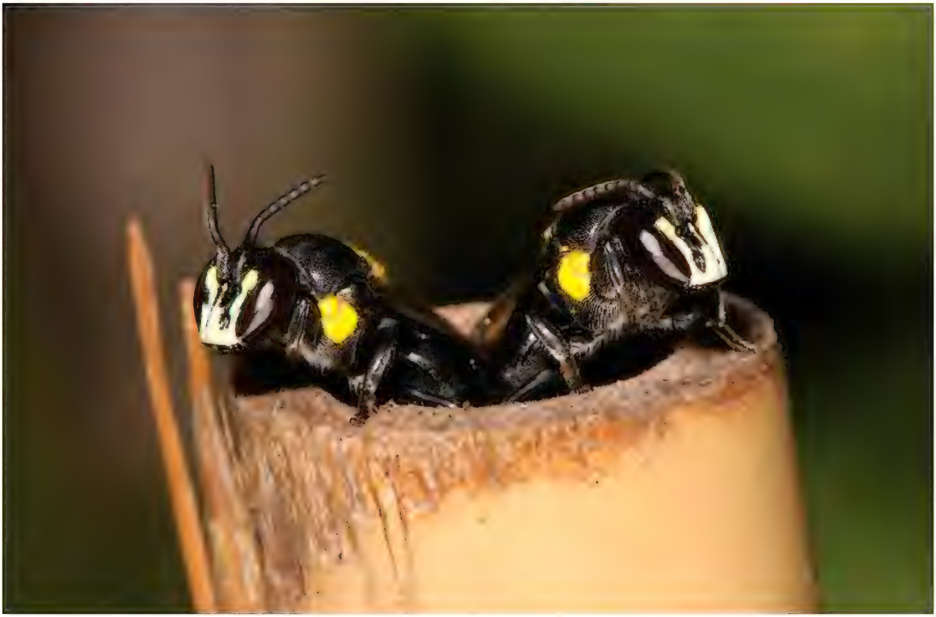


Fig. 5. *Meroglossa itamuca* males emerging from nest

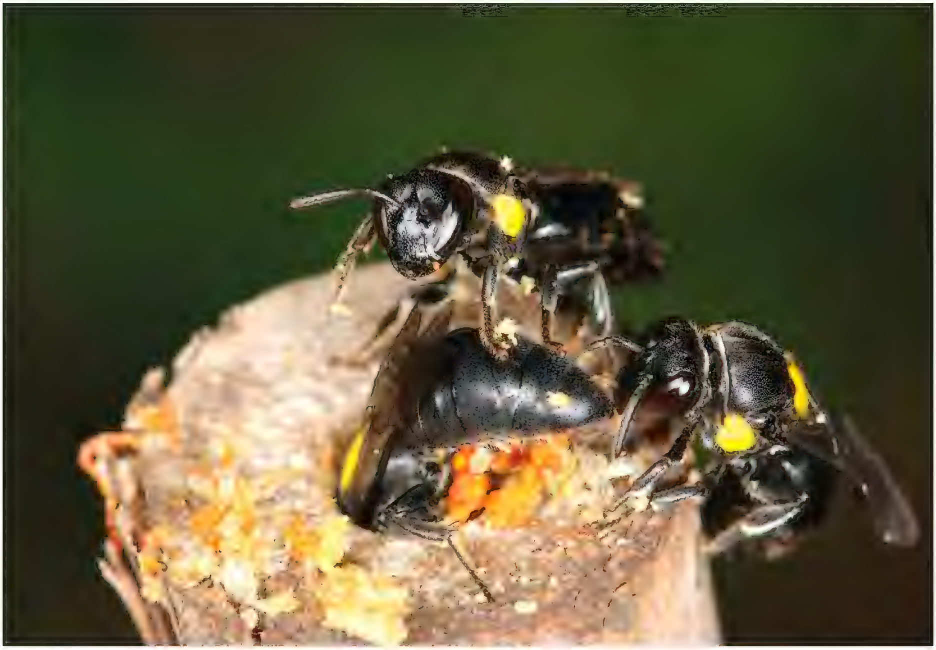


Fig. 6. *Meroglossa itamuca* females cleaning their nest

Many of my bee-attracting plants are growing in pots, and the bees will happily visit them, especially when the sun is on the flowers. It's a good idea to have a variety of plants that flower in the different seasons so that if native bees are around, they have something to feed on!

Another good thing about having a variety of flowering plants is you'll attract other pollinators such as butterflies, hoverflies, beetles, wasps and moths. There is always insect activity here, even in the Brisbane winter.

Perhaps another reason I have lots of insects is that I don't use any pesticides. I leave it to the birds and other insects to control things naturally.

Through trial and error, I am now able to provide sources of pollen and nectar, as well as material for nests, a number of different styles of bee hotels, and areas in the garden where burrowing bees can make their nests. With the right flowers and plants, native bees in your area will appear in your garden.

Some plants for attracting native bees in South East Queensland

Native plants

Melaleucas esp. *M. linariifolia*, Kunzeas, Leptospermums, Callistemons, Eucalypts, Dianellas, Plectranthus, Syzygiums, Hibbertias, Westringias, Native Daisies

(*Brachyscome* spp. and *Xerochrysum bracteatum*) and Yellow Pea flowers e.g. *Pultanaea* and *Dillwynia*, Purple Pea flowers e.g. *Hovea* and *Hardenbergia*.

Exotic plants
Salvias, Lavenders, *Grewia occidentalis*, Perennial Basil, Crepe Myrtle (*Lagerstroemia* spp.), *Rondeletia*, African Daises, (*Osteospermum* spp.), Purple (Blue) Ginger, (*Dichorisandra* spp.), Plants in the Solanum family e.g. tomato, chilli, eggplant and capsicum and the herbs (anise hyssop, motherwort).

Reference

Houston, Terry, 2018. *A Guide to Native Bees of Australia*. CSIRO Publishing, Melbourne.

Life history notes on the Macleay's Swallowtail, *Graphium macleayanum* (Leach, 1814) Lepidoptera: Papilionidae

Wesley Jenkinson

Introduction

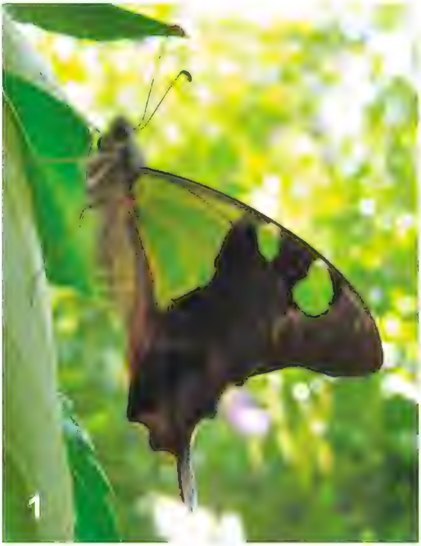


Fig. 1. Resting adult

The well-known Macleay's Swallowtail (Fig. 1) is a handsomely coloured butterfly with two subspecies in Australia.

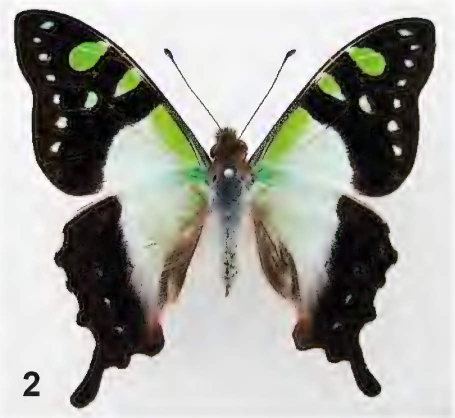
The nominate subspecies is distributed sporadically from north-eastern Queensland to southern New South Wales and *G. m. moganna* occurs from the montane region of southern New South Wales into Victoria and Tasmania (Braby, 2000 & 2016). It is primarily a montane species along the Great Dividing Range, but is also known from lower altitudes in some coastal and subcoastal areas.

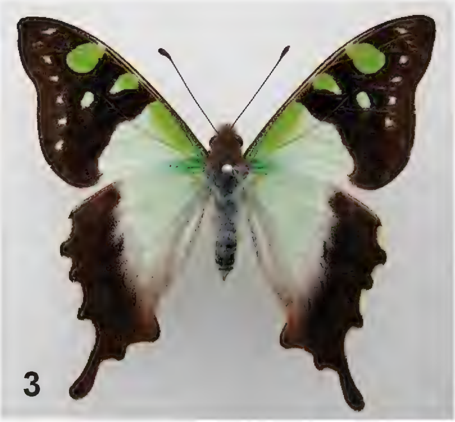
Adults of this exquisite species can be observed in a variety of habitats including rainforest, wet sclerophyll forest, eucalypt open forest and suburban gardens adjacent to suitable habitat where host trees are established. They are rapid fliers and typically males can be observed hilltopping or flying continuously above high tree tops and across mountain summits. Females can be seen busily flying around the host trees. When hilltopping together with male *G. choredon* (Blue Triangle butterflies) individuals are often seen constantly chasing one another around for long periods.

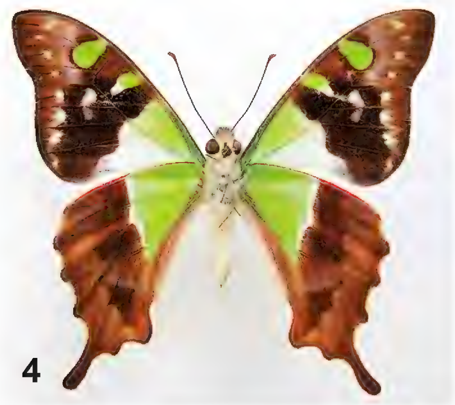
Both sexes, with wings vibrating rapidly, feed momentarily at a variety of small native and exotic flowers; a typical flight behaviour of the swallowtail genera. They find the flowers of the exotic Lantana (*Lantana camara*) and Balloon Cotton Bush (*Gomphocarpus physocarpus*) particularly attractive. They frequently fly close to the ground whilst foraging for flowers. Similarly ovipositing females may also be observed close to ground level if fresh shoots are available.

Within the nominate subspecies there is minor variation in the size of the greenish-white area on the upperside, the width of the black terminal band and the size of the green costal spots on the forewing upperside. The subcostal spots on the hindwing upperside may sometimes be absent. The underside hindwing markings also show slight variation in their size and shape and some females may have a lilac tinge on the terminal band. The green colouration tends to fade to yellowish-green on specimens that have been retained in collections for many years. Specimens reared indoors will also result with pale yellowish-green markings, rather than the strong green coloration.

The sexes are very similar in appearance. Males can be separated by the presence of long, fine, brown and white, sex hairs, in a fold dorsally along the inner margin of the hindwing. The inner margin is also coloured dark brown which in the female is only the pale ground colour. The female abdomen is also shorter and wider. The wingspans of the males and females pictured are 55 mm and 60 mm respectively (Figs 2–5).







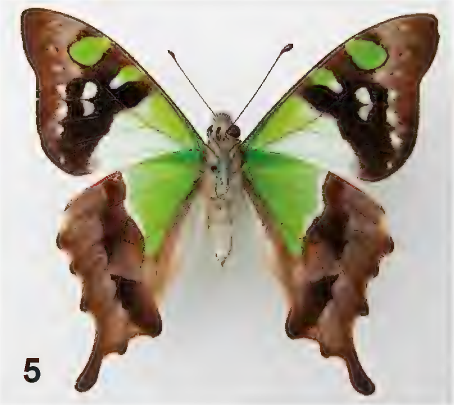


Fig. 2. Male upper **Fig. 3.** Female upper **Fig. 4.** Male under **Fig. 5.** Female under

Life history

The life history of *G. macleayanum* has been documented by several authors (Common & Waterhouse, 1981; Braby, 2000). Most recently Sankowsky (2020) gives a particularly thorough and well illustrated account.

Larvae have been recorded feeding on host plants within the Lauraceae, Monimiaceae, Rutaceae and Winteraceae families, by various authors (cited in Braby 2000).

In January 2018 a female was observed laying several eggs on *Daphnandra apetala* growing in the rainforest understory at 'Bindarrabi', a private property in the montane region of the Queensland /New South Wales Border Ranges. She typically fluttered busily around the host plant. Once a suitable spot was located, she lightly balanced on the host plant, and with wings beating rapidly, curled her abdomen below a leaf, ovipositing a single egg. Most eggs were laid on fresh shoots but one egg was laid on the underside of a mature leaf. Six eggs were collected and raised to adults on a known native host tree, Brown (or Three-veined) Laurel (*Cryptocarya triplinervis*).

Eggs were pale green, smooth, spherical, and approximately 1.2 mm in diameter. (See egg day three, Fig. 6).

Larvae consumed the eggshells when they hatched. They later chewed from the outer edge of the leaves and rested openly on a silk pad on the upperside of the host leaves (similarly recorded by P. Couper and R.P. Mayo in Braby 2000) and chiefly fed during the night. Occasionally they were also observed feeding at dusk and during the day. As in other Papilionidae the larvae have a strongly pungent-scented fleshy osmeterium (Crossley & Waterhouse, 1969) that they evert from behind the head to deter predators when disturbed. The larvae completed five distinctly patterned instars with the largest larva attaining a length of 32 mm (Figs 7–11).

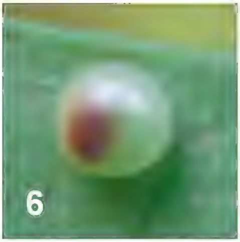
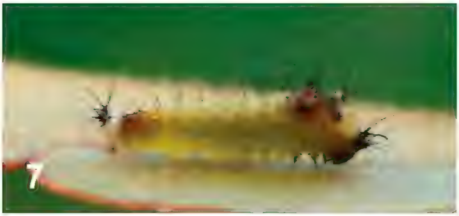
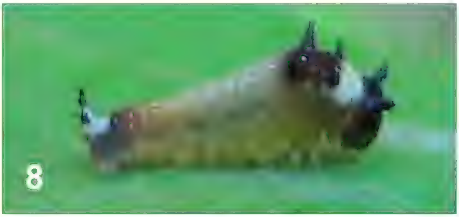


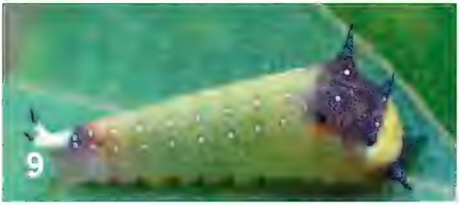
Fig. 6. Egg day three

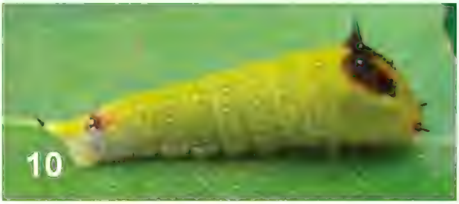
The pale green pupae (the largest specimen measuring 25 mm) were located below leaves of the host plant and were attached with silk by the cremaster and a central silk girdle (Figs 12, 13).

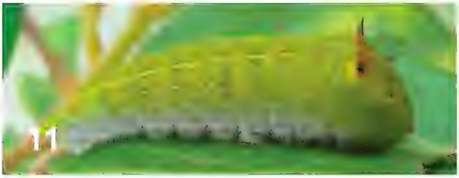
The first adult to emerge had an egg duration of 5 days, larval duration 31 days and pupal duration of 11 days. The last adult to emerge had a similar egg and larval duration and emerged 12 days later. Within the boundary of the Scenic Rim Regional Shire, south of Brisbane, I have adult records from September through to May, but excluding January and March. Adults are most likely on the wing during these two unrecorded months in this region. There are at least two or more generations per year in this area.

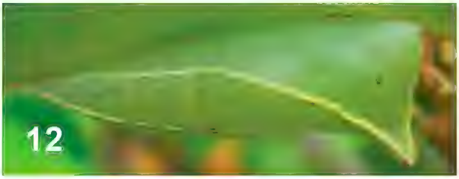












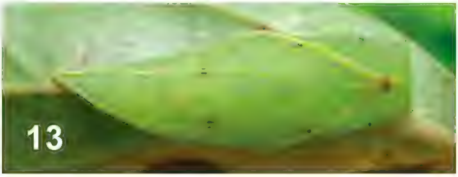


Fig. 7. First instar larva **Fig. 8.** Second instar larva **Fig. 9.** Third instar larva **Fig. 10.** Fourth instar larva **Fig. 11.** Fifth instar larva **Fig. 12.** Pupa (lateral view) **Fig. 13.** Pupa (dorsal view)

Acknowledgements

I thank John Moss for commenting on the manuscript & also (the now late) Doone Wyborne & Carol Shantal for allowing access to their property "Bindarrabi" in north-eastern New South Wales.

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Iso with isopods

Colleen Foelz

July/August 2021

Lockdown, Day 3

For the fifth or sixth time in the hour I found myself inquisitively poking about in my newly acquired isopod colony, leading me to wonder if perhaps there was more to life. Concluding that there wasn't, I googled 'isopod care', and also saw on my newsfeed that we had 13 new locally acquired Delta cases. 'Iso' wasn't ending any time soon.

'Iso'… hmmm … 'Iso with isopods'. Suddenly I had a winning title, time, but alas no content. These little critters had been on their way to support a display featuring an exhibit of the deep-sea isopod *Bathynomus giganteus*, referred to as super giants as they can grow to 50 cm in length. Then Covid-19 intercepted. My hunt for a story began, with time on my hands, and only these strangely endearing invertebrates as company for the duration.

My isopod starter kit was kindly provided by 'Insects and Me' founder Davina Paterson (Fig. 1). She reassured me that the basic care for these scavenging crustaceans was straightforward – a spray of water, a slice of fruit or veg, and cuttlefish 'bone' or crushed eggshell for calcium.

Crustaceans have more legs than their insect and spider arthropod relatives. The terrestrial variants (isopods and amphipods) have 14 (Fig. 2). Isopods are commonly referred to as slaters, woodlice (note they're not lice) or *butcher boys* (see Acknowledgments). Those that can roll up into neat little armoured balls (e.g. *Armadillidium* spp.) are called roly polies or pill bugs (but they are neither true bugs nor pills). Reconfiguring oneself into a sphere like this is known as 'conglobation', a catchy word none of us get to use much.

Fig. 1. Davina Paterson and friends from her business 'Insects and Me' (credit Davina Paterson)

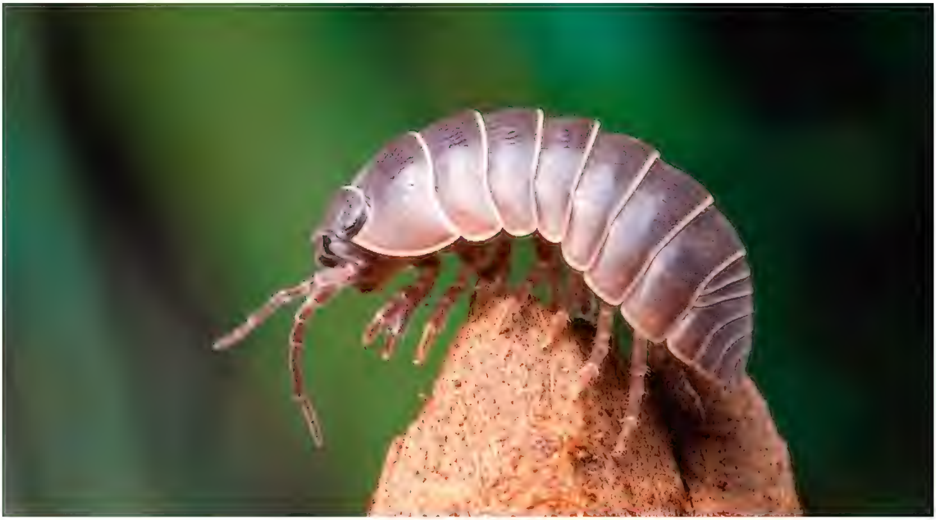

Fig. 2. A slater in profile, © Alan Henderson – Minibeast Wildlife

Only the Armadillidiidae family of isopods can achieve this feat, not the closely related but easier to pronounce 'Armadillidae'.

Googling 'conglobation + armadillo' seemed like a good idea at the time (of which as I said I had a lot) and led me to the elaborately titled 2020 paper 'Are terrestrial isopods able to use stridulation and vibrational communication as forms of intra and interspecific signalling and defence strategies as insects do? A preliminary study in *Armadillo officinalis*'. Cividini *et al.* (2020) state that pill bugs can make sound by rubbing the edges of scales together between the 4th and 5th pereopods (technical term for limbs of some crustaceans including isopods). These scales only come into contact when in the defensive conglobated posture. This has apparently been known since German 'myriapodologist' Karl Wilhelm Verhoeff (1908), ranked as one of history's three most prolific millipede taxonomists, found time to mess about with roly polies in Sicily in 1908. If not for the pandemic I never would have known this. Based on their experiments Cividini *et al.* (2020) speculated that the vibrations created by the pereopods may both deter a threatening predator and warn conspecifics of the danger.

Then out of the blue and into my care came a potentially unnamed pill millipede captured in a remote north Queensland cave. What are the chances? Pill millipedes (which are millipedes, but still not pills) are sometimes confused with pill bugs. They are relatively stout compared to other millipedes (Fig. 3). Like the rest of the class Diplopoda, they have two pairs of legs for each of their 11 to 13 body segments. Pill millipedes in Australia belong to the Order Sphaerotheriida and can also roll into a ball when disturbed, thereby completely concealing their head and legs (Fig. 4).

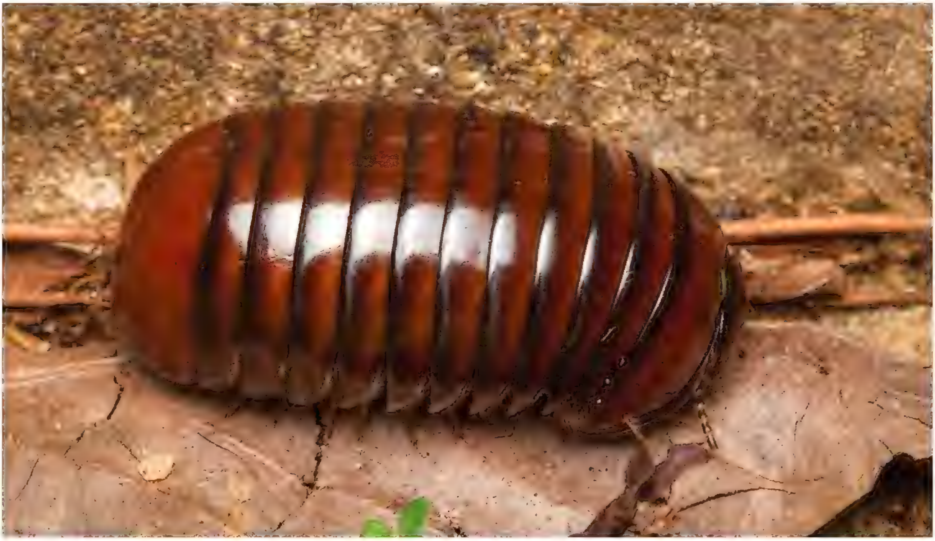

Fig. 3. The stout shape of the pill millipede, © Alan Henderson – Minibeast Wildlife

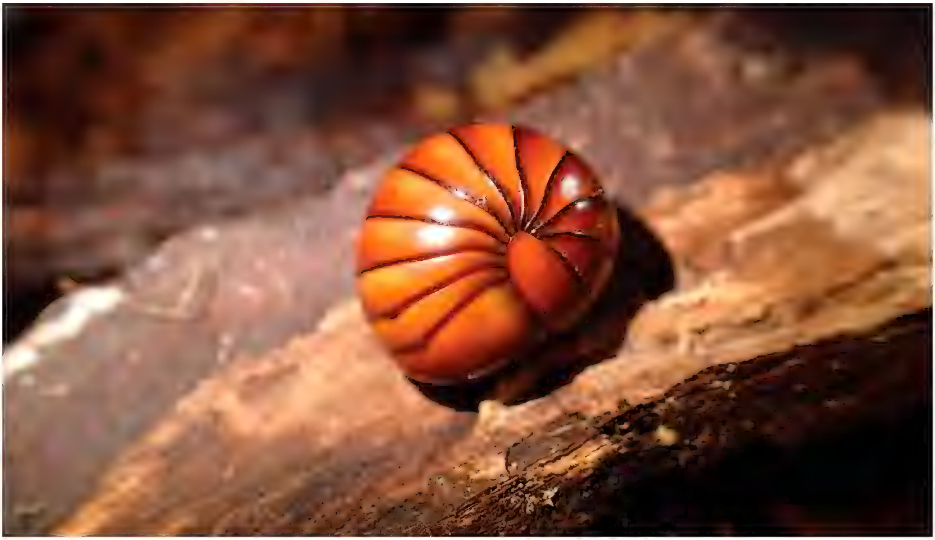

Fig. 4. Milly (not her real name) the pill millipede demonstrating conglobation (credit Colleen Foelz of edenink)

Day 6 of lockdown

By now I'd discovered that zucchini skin was particularly palatable to the isopods. They mow small grazing tracks as they slowly etch away the dark green surface, cutely waggling their antennae as they go. Yes, I know, I need to get out more, but remember I was in LOCK DOWN. I also read that they eat their dead, a macabre though convenient aspect of their husbandry.

More gentle poking about in the colony showed it to be a mixture of ballers and non-ballers – most likely to be *Armadillidium vulgare* and *Porellio pruinosus.* Isopod care notes say that balling behaviour helps to conserve water and that the non-roller isopods (e.g. *Porcellio* spp.) require a damper environment as their external gill-like organs (called pleopods) can't be protected from desiccation by conglobating. But, I wonder, has anyone studied this, or is it just speculation?

Googling 'conglobation + water loss' did not fail me. I discovered 'Conglobation in the pill bug, *Armadillidium vulgare,* as a water conservation mechanism', Smigel and Gibbs (2008) studied this by forcing conglobation of pill bugs using dental rubber bands (Fig. 5). Perhaps they needed to get out more themselves. They described terrestrial isopods, revealing that they lack 'cuticular lipids and the elaborate spiracular apparatus of insects', some genera have 'evolved invaginated lungs in the exopodites that form pseudotrachea' and they actively 'imbibe water through the mouth *and* anus!'. Gold! Oh yes, Smigel and Gibbs (2008) *did* show that the behaviour appeared to reduce water loss.

Further reading throws up yet another satisfying word – 'thigmokinesis', which describes the tendency of slaters to reduce movement when close to a solid object, including other slaters. Incidentally they also demonstrate negative photokinesis (attraction to dark places, I get that), and move faster and turn more often when in unfavourable environments, but slow down when in a favoured dark and humid locale. These behavioural adaptations all help to keep them in ideal conditions and avoid water loss. It also makes them easy to manage and observe in a well-designed exhibit as they prefer to 'escape' into the habitat provided rather than escape over the edge of an open container.

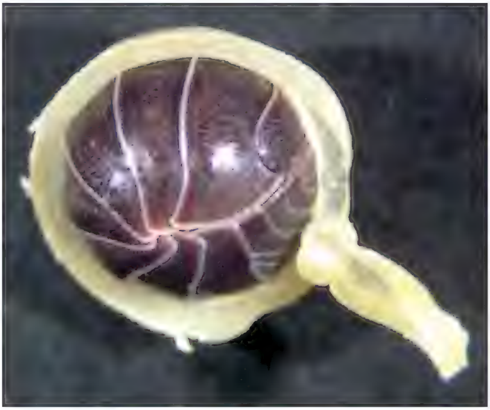

Fig. 5. An isopod subjected to forced conglobation by a dental rubber band (credit Smigel and Gibbs, 2008)

Lockdown ends

Lockdown ended and the colony executed their exhibition duties, achieving fame but not fortune under the spotlight and public gaze. But I found that I rather missed observing roly poly life. What's more, ALDI obliged by selling designer isopod homes promoted under the guise of 'seedling planters'. The transparent cover is ideal for viewing, it seals well around the edges and has two openable slide windows. These help to regulate ventilation and humidity and make excellent food delivery chutes. I rehoused them in their new 'Isorarium' (yes, I just made that up, it's not even in google) with a bedding of sphagnum moss and peat, topped with compost, moss, rotting pitted wood, bark and a few decorative ferns (Fig. 6).

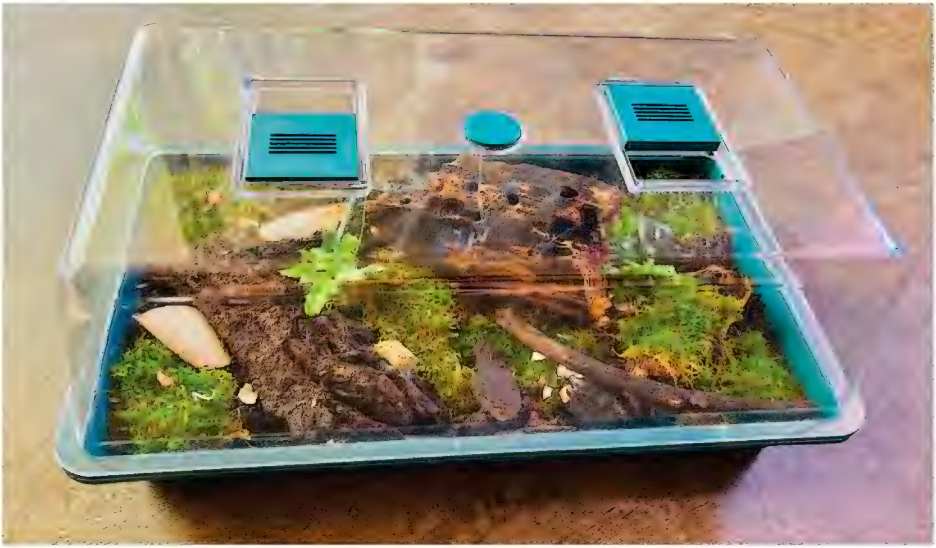

Fig. 6. The 'Isorarium' (credit Colleen Foelz of edenink)

In October I ran away on an insect-seeking road trip for a few weeks and left my colony of crustaceans to be baby sat by a work colleague, trusted because he keeps ants. What could possibly go wrong. Well, nothing did. In fact, on my return I was greeted with hundreds of white miniature pill bugs! The pitter patter of tiny pereopods! The females brood their eggs in a pouch called a marsupium. Some lay the eggs whilst in others the eggs hatch internally and young are birthed as tiny nymphs.

Anyone in the insect world will know that no Australian entomologically related presentation, paper or book is truly complete without mention of the famous Dr Geoff Monteith or a species named after him. So it happened that a random lunch encounter with a colleague brought to my attention the scarab beetle of the subfamily Ceratocanthinae. Australia's two genera comprise seven species localised in eastern Queensland with six endemic to Australia (Ballerio, 2013). They are of interest here because they roll up too and,………. drum roll…. there is a local species called *Cyphopisthes monteithi*. So, with that connection rounded off, my story telling felt complete. For some great images and video of the oddly shaped ceratocanthinids doing their conglobating transformer act I recommend Wizen (2017).

My takeaway from all this is that delving into the world of invertebrates comes with a warning! You'll not just be taken down a rabbit hole, but through an endless maze of criss-crossing warrens. Be prepared in your observations and google searches to be bedazzled by what you see and learn, by what people have taken the time to study and document, and the arcane tangents they enthusiastically explore. It's a world too often overlooked or dismissed by the casual observer. Drawing attention to its wondrousness is one of the true joys in my life.

Acknowledgements

I thank Alan Henderson of Kuranda-based MiniBeast Wildlife for generously providing his images. Thanks too to Davina Paterson of 'Insects and Me' for taking on my challenge of capturing herself AND isopods in the one image. She had to engage a friend's help and do a bit of wrangling but together they got the job done. Thanks also goes to natural history whiz Steve Wilson for casting his eye over my story and providing insightful value adds (e.g. I'd never heard of *butcher boys*. Google says it's a Melbourne northern suburbs thing).

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Notes on the Tawny Coster *Acraea terpsicore* (Linnaeus, 1758) (Lepidoptera: Nymphalidae: Heliconiinae) from northern Queensland

David A. Lane

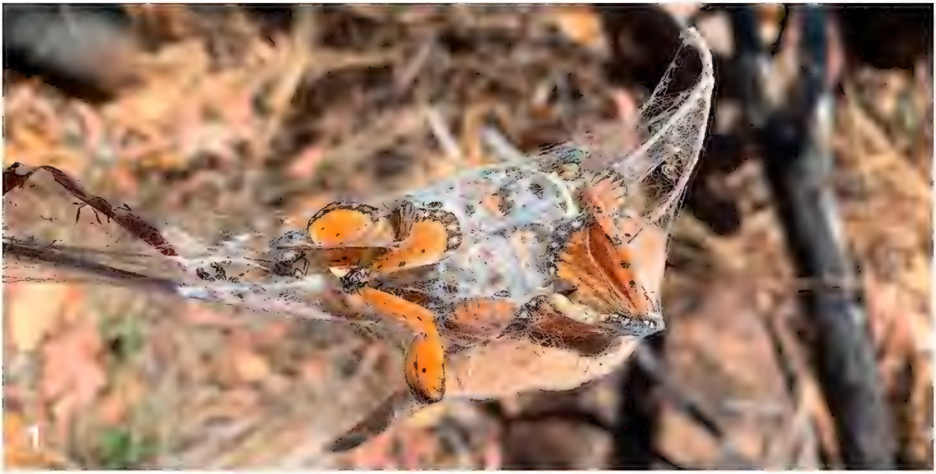
Introduction

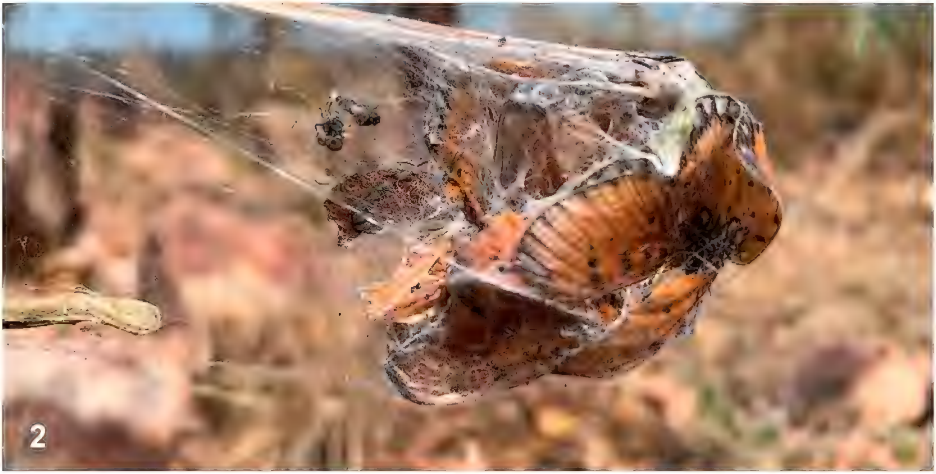
Much has been written recently on the travelling exploits of the Tawny Coster, *Acraea terpsicore* (Linnaeus, 1758), and its migratory ability to travel vast distances in relatively short time frames. It is a recent arrival to Australia (Sanderson *et al.* 2012; Braby *et al.* 2014; Ham 2020) and since has spread through much of tropical northern and eastern Australia, including semi-arid zones of Queensland (Ham 2020). Just recently, Denton (2021) recorded the species from Boondall in Brisbane, and Franzmann (2021) published an interesting report of an observed mating, also at Boondall, between the Tawny Coster and the native Glasswing, *Acraea andromacha* (Fabricius, 1775). More recently the Tawny Coster was recorded from New South Wales at Coffs Harbour in November, 2020 (Shakespeare 2021), with a second unpublished observation of the species in New South Wales at Byron Bay on 22 February, 2021 (C. G. Miller *pers. comm.*).

Observations

Details of the biology and life history of the Tawny Coster in Australia were published by Braby *et al.* (2014), however little seems to have been observed about its natural enemies. Tawny Costers have been a regular feature of the north Queensland butterfly fauna since around 2017, with an observed preference for slightly drier habitats than much of the Wet Tropics region, with higher numbers seen in drier areas as compared to much wetter areas. Hilltopping is a regularly observed activity of Tawny Costers in areas west of Atherton, often in company with the native Glasswing butterfly – it is usually only males of both species seen on such hilltops. On hilltops in the Chillagoe area, due west of Mareeba, Tawny Costers and Glasswings often share the same hilltops, with Tawny Costers being the most regularly seen of the two butterflies. The occasional interaction of minor ‘dogfights’ between the two species does occur, suggesting defensive or territorial behaviour, but appears to be short in duration and not of critical consequence. Tawny Costers have a preference to roost on the very summit of the hilltop, often picking a stem of a low woody herb, grass stem or low shrub on which to perch. Glasswings seem to select slightly lower vegetation on the outer edge of the hilltop, usually perching on low shrubs. Both species will take frequent flights around the hill summit, so that any ‘dogfighting’ interaction occurs only in flight on the summit.

On one such hilltop, several web traps of the spider, *Phryganoporus candidus* (L. Koch) (Family Desidae) were noticed to contain multiple adults of entrapped Tawny Costers, along with a multitude of other trapped insects including flies, beetles, and bugs (Fig. 3). The web traps contained multiple spiders and entrance holes, which could explain the extensive insect entrapment using large volumes of silk, which included numbers of Tawny Costers and other insects. This spider is widespread throughout much of Australia (Gray 2002). Two traps closely observed, contained separately, eight males, (Fig. 1) and eleven males and a female (Fig. 2) Tawny Costers.





Figs 1, 2. Spider web traps showing entrapped Tawny Coster butterflies

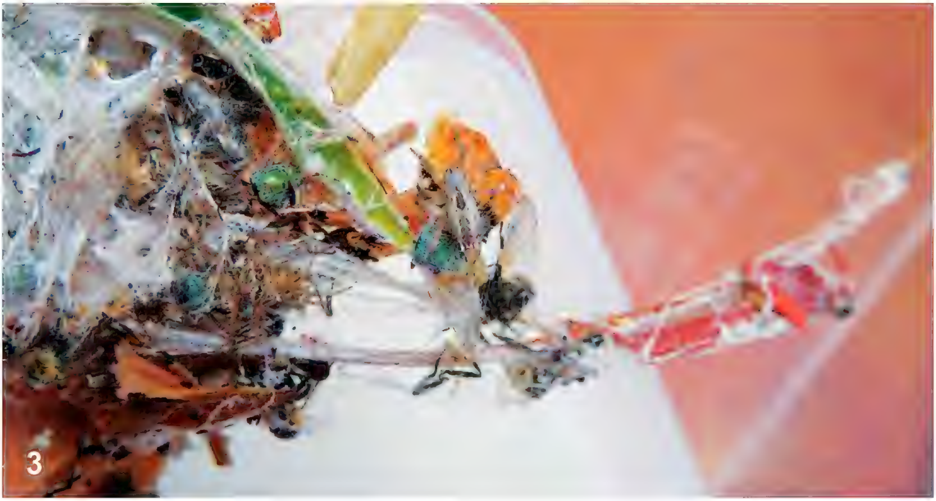


Fig. 3. Detail showing adult spiders and multitude of entrapped insect species

The web traps were constructed on exposed stems of low woody herbs, right on the very hilltop summit, where the Tawny Costers usually selected to roost. The identification of the woody herbs was not confirmed, as the plants had died back due to the dry winter conditions at the time of the observations. Interestingly, no Glasswings or other butterfly species were found in the web traps. The lack of Glasswings in the traps is suspected to be because of their utilising different roosting locations on the hilltop. These observations are of interest as they identify a potential predator and natural enemy for the Tawny Coster butterfly in northern Queensland.

Acknowledgements

Dr Helen Smith, Australian Museum, Sydney is sincerely thanked for identifying the spider and providing relevant literature and related information.

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The genus *Epidesmia* (Lepidoptera: Geometridae)

Peter Hendry

Introduction

The newly raised subfamily Epidesmiinae (Geometridae) includes the genera *Ecphyas* Turner, 1929, *Systatica* Turner, 1904, *Adeixis* Warren, 1897, *Dichromodes* Guenée, 1857a, *Phrixocomes* Turner,1930, *Abraxaphantes* Warren, 1894, *Phrataria* Walker, [1863] and *Epidesmia* Duncan and Westwood, 1841 (Murillo-Ramos *et al.* 2019). The genus *Epidesmia* is mostly Australian but has one species, *E. reservata* (Walker, 1861) occurring in New Guinea. The genus contains nine Australian species and at least one unnamed. *Epidesmia tricolor* Duncan and Westwood, 1841 is the generic type species. The males of *Epidesmia* have pectinated[1] antennae while the female antennae are filiform[2], except in the case of *E. phoenicina* Turner, 1929, which in the females have short pectinations.

Species

Epidesmia tricolor (Duncan and Westwood, 1841) (Fig. 1)

The type location was given as New South Wales, with the original specimen coming from the collection of Rev. F. W. Hope (Duncan and Westwood, 1841). With a wingspan 52–65 mm, this is the largest and most spectacular of the *Epidesmia* species. With a rich chocolate brown ground colour, the forewing is broken midway by a curved white line, which projects outwards onto the termen[3], just below its middle. The hindwing has the same ground colour but has a large yellow spot in the middle. My only experience with this species was in November 2004, i.e. a single specimen (Fig. 2) collected (by J. Moss) in northern New South Wales, near the Queensland border, on the north side of Cobaki Lakes. It was in a patch of *Gahnia clarkei* in which we were, at the time, researching a colony of the satyrine butterfly *Tisiphone abeona morrisi* Waterhouse, 1914 (Varied Sword-grass Brown). At the time J. Moss commented that *E. tricolor* could almost be mistaken for a mimic of *T. a. morrisi*, but for what purpose we could not fathom. J. Moss had also collected several specimens in February 1975, at Mt. Tamborine, which is generally considered the northern limit for this species. However, W. Jenkinson and J. Moss collected two specimens in November 2014 at Kroombit Tops, about 150 km north west of Bundaberg. From this northernmost record, the distribution of *E. tricolor* appears to stretch south through south eastern Queensland down the eastern coast of New South Wales and into Victoria, at least as far as the Cann River. With these records, plus five records from online with collection data, it appears that *E. tricolor* is on the wing, at least between October to May. Captive larvae have accepted *Leptospermum* (Myrtaceae), a V. J. Robinson record (Common, 1990).

Epidesmia chilonaria (Herrich-Schäffer, 1855) (Fig. 3)
Wingspan 35–42 mm. Herrich-Schäffer (1855) figured this species (Fig. 4) and in his description gave a brief note of the wing venations and stated, "*antennae with a simple row of protruding, obliquely tilted comb teeth, palps – as long as the head*"; with the original description under the genus *Hemagalma* (Herrich-Schäffer, 1855). The type location was given as New Holland (Australia). *E. chilonaria* was figured again by Guenée, 1857b (Fig. 5) as the synonym *Panagra aurinaria*. This species is conspicuous by its orange hindwing and it is common on my property at Sheldon, Redland City, Queensland. Recently, I observed them at this location in October and November 2019, and January 2020. I have collected specimens from Sheldon in August 2007 and from a property 12 km north of Deepwater New South Wales in April 2013. It is on the wing from August to April. I found no adult records from May to July. *E. chilonaria* is mostly found common from October to January. W. Jenkinson and J. Moss collected a specimen during their November 2014 trip to Kroombit Tops making this the most northern record for this species I have found. Apart from this record it occurs from the Sunshine Coast, Queensland, through New South Wales, including the ACT, into Victoria reaching the eastern suburbs of Melbourne. Common, 1990 raised larvae on *Callistemon saligna* (now *Melaleuca salicina*), *Eucalyptus tereticornis* and *Angophora floribunda.*

Epidesmia tryxaria (Guenée, 1857c) (Figs 6♂ and 7♀)
Wingspan 28–34 mm. The original description was based on three males from Tasmania and was named under the genus *Panagra* Guenée, 1857c. I have collected this species from Sheldon in the months of February, March, May, June and August; from a property near Deepwater in New South Wales, in March and April; and from Springbrook, south eastern Queensland, in November. It is on the wing throughout the year with peak periods in March and October; less so in June. *E. tryxaria* is recorded along the east coast, as far north as Kuranda, Queensland, through New South Wales and into Victoria, almost to the SA border. While originally described from Tasmania, I could find no recent records from that state. This species is like *E. perfabricata* (Walker, 1861); one notable difference is the dark chocolate-brown palpi of *E. tryxaria*, white below, compared to those of *E. perfabricata* which are grey (Fig. 8: *tryxaria* left [verso] and centre [recto], *perfabricata* right [recto]). Lower, 1893a described the synonym *Epidesmia phaedropa*. Nothing is known of its life history.

Epidesmia hypenaria (Guenée, 1857d) (Figs 9♀, 10♂)
Wingspan 32–41 mm. Distinguished from all other *Epidesmia* species by the extreme length of the palpi and the extra length of the pectinations of the male antennae. Another distinguishing feature is that similar looking species have at least a rudimentary post medial line[4] that runs across the forewing and continues across the hindwing, whereas in *E. hypenaria*, the hindwing has no such line work, or at best extremely faint. The types of *E. hypenaria* are a male and female from Tasmania, originally described under the genus *Panagra*. Felder and Rogenhofer (1875) figured (Fig. 11) a male synonym under the name *Hemagalma inspersa* Felder and Rogenhofer, 1875. Its flight period is from September to April, peaking in December. The most northern record I have for this species is from a property 12 km N of Deepwater, in April 2010 and March 2012 (PH collection). Its distribution continues south through eastern New South Wales, including the Australian Capital Territory, through southern Victoria and into South Australia; a state I have only one record from, i.e. from E. Beaver (Fig. 10♂), collected on 28 November 2017 at Millicent, approximately 54 km from the Victoria border. It also occurs in Tasmania. Its life history is unknown.

Epidesmia perfabricata (Walker, 1861) (Fig. 12)
Wingspan 28–34 mm. Walker described the species under the genus *Panagra* from a male specimen collected at Moreton Bay (Brisbane) and presented to Walker by a Mr. Gibbons. *E. perfabricata* looks most like the male of *E. tryxaria*, and tends to be grey, while *E. tryxaria* tends to be brown. The two can be separated by the palps as noted above (Fig. 8). I have only collected a single specimen of this species, from the Blackdown Tableland, west of Rockhampton, on an expedition with W. Jenkinson in October 2017. The most northern record I found for this species is of J. C. Keast at Mt. Surprise, some 300 km south west of Innisfail, in March 2016. From there its known distribution occurs south along the east coast of Queensland, through New South Wales and into Victoria, and west as far as Werribee Gorge. Flight times have been recorded from October to March with a peak period of December to January. Its life history is unknown.

Epidesmia reservata (Walker, 1861) (Fig. 13)
With a wingspan of 22–26 mm, this is the smallest *Epidesmia*. Walker also described this species under the genus *Panagra* from a specimen collected at Moreton Bay by Silvester Diggles. Most like the females of *E. tryxaria*, it differs in size; and the colour of the palps are much darker in *E. tryxaria*. Meyrick (1890a) noted: *E. reservata* has "*cilia whitish, with a dark fuscous basal line becoming obsolete*

towards anal angle[5]." While I have no specimens in my collection, W. Jenkinson has collected it from south west of Gin Gin, Queensland, including Beaudesert and Springbrook. It has been recorded from New Guinea and Melville Island, Northern Territory. On the Australian mainland it is known from northern Western Australia in the Kimberleys at Vansittart Bay in January 2015 by J. and A. Koeyers. *E. reservata* also occurs in the north of the Northern Territory and down the east coast of Queensland including Stradbroke Island and into New South Wales, as far south as Tinonee, south of Taree. Flight times are all year round with peak periods in November and April. Its life history is unknown.

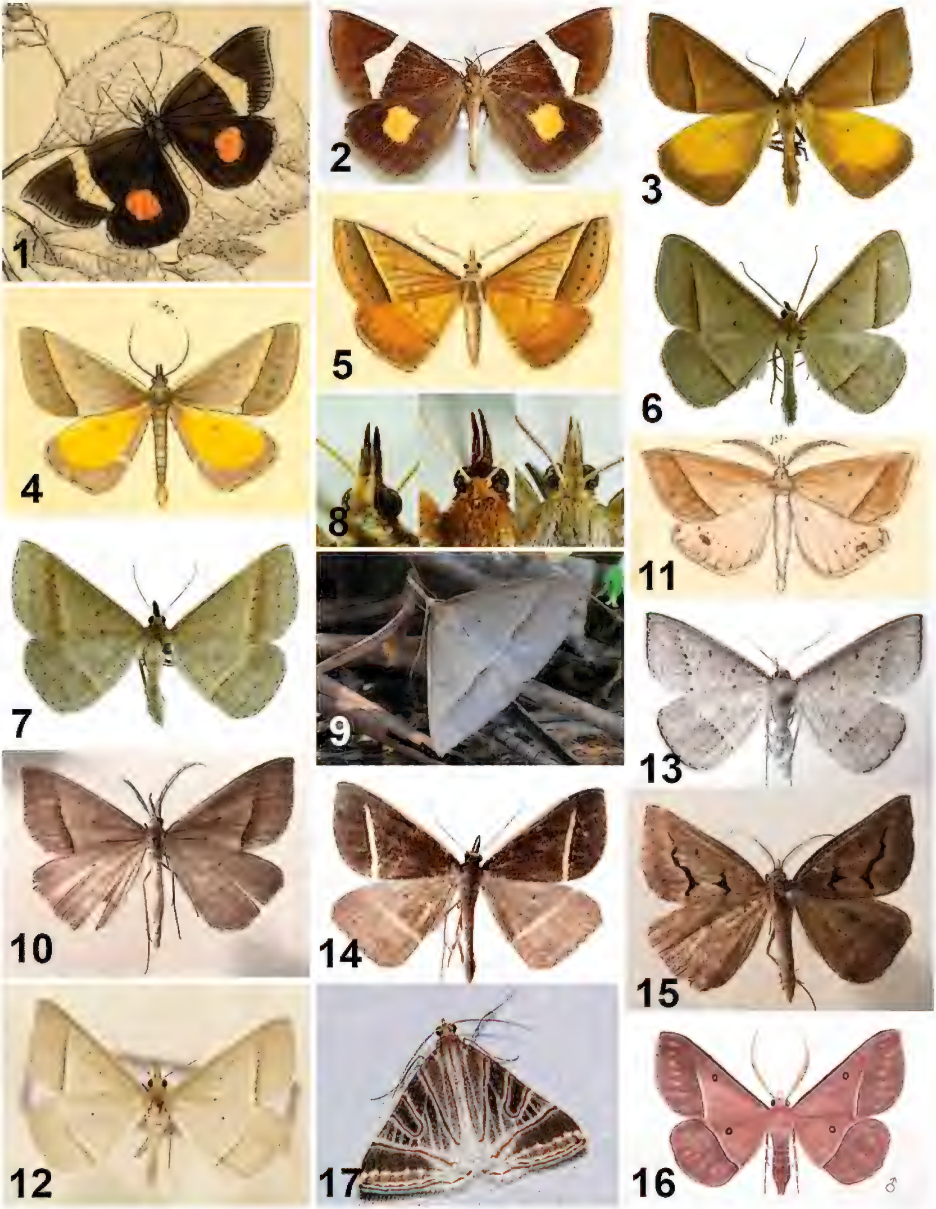
Epidesmia oxyderces Meyrick, 1890b (Fig. 14)
Wingspan around 30 mm. Named by Meyrick from a single male he collected himself, in what he described as a 'jungly' swamp near Sydney in November, perhaps in 1889. A distinctive species with a dark brown forewing and light brown hindwing, both of which are broken by a post-medial white line, not reaching the costa in the case of the forewing. W. Jenkinson has one specimen collected from Springbrook, in November 2016. Based on Turner (1929a) its distribution is from Mt. Tamborine, in south eastern Queensland to Sydney, NSW. *Epidesmia oxyderces* is the least recorded of the genus. It is on the wing in November and December based on only three specimens I could find with collection data. This flight period is bound to be expanded with more collection records. Nothing is known of its life history.

Epidesmia brachygrammella Lower, 1893a (Fig. 15)
Wingspan 32–40 mm. This species was named from a male specimen collected by a W. H. F. Hill at Croydon, Victoria. It occurs in south eastern Victoria, from near Melbourne to the NSW border. It has also been recorded in New South Wales as far north as Mt. Keira, north east of Wollongong. Anonymous 2010a shows one Australian National Insect Collection (ANIC) record from Valencia, north east of Darwin in the Northern Territory. If this is correct, the species appears to have a very disjunct distribution. It is generally distinct from all other species by two dark angular lines on the forewing; one at one forth[6] the other post medial[4], both starting short of the inner margin[7] and finishing well short of the costa[8]. However, Moths of Victoria Part 4 (Marriott, 2012) gives this species the common name of Variable Epidesmia, based on the fact that it can be without the dark lines on the forewings, and this variety looks much like *E. hypenaria*, though with much shorter palps. Known flight times, based on scant data, are November–December. Nothing is known of its life history.

Epidesmia phoenicina Turner, 1929 (Fig. 16)
Wingspan about 40mm. This is the most recently named species. A. J. Turner named it from a single male specimen from Meringa (south of Cairns), at the time in the collection of G. M. Goldfinch, and one female collected by F. P. Dodd at Kuranda. In his description Turner (1929b) noted "*The short pectinations of the ♀ antennae are a peculiar character.*" While all species of *Epidesmia* except *E. tricolor* have a small dark dot in the cell of both the fore and hind wing, *E. phoenicina* has larger pale spots encircled by a darker line. Generally, the outer third of both wings being a rich brown colour, are darker than the inner two thirds. Recorded flight times include November to January, including April and May. It appears to have a north Queensland distribution with records from Kuranda south to Kennedy, just north of Cardwell. Anonymous 2010b has one ANIC record from the Brisbane suburb of Windsor by A. N. Gillison dated 8/05/1984. I have had no experience with this species and Fig. 16 is an illustration I painted myself based on several on-line images. Nothing is known of its life history.

Epidesmia sp. ANIC1.
This unnamed species is the dullest of the species; uniformly grey, the forewing slightly darker, the costa brownish towards the base with a white edge, palps brown, small dark spots in the cells of both fore and hind wings with a second set of spots on the forewing below the cell just above the inner margin and a post medial line, on the forewing, made up of a series of dots. All three specimens represented on the Anonymous 2010c were collected by Ted Edwards on 02/11/1991 at Brookfield Conservation Park, Blanchtown, South Australia. These specimens may prove to be the same species as those represented in Moths of Victoria Part 4 as unmarked *E. brachygrammella.*

Other species once referred to as *Epidesmia*
Meyrick, 1890c sank Walker's *Phrataria* as a synonym of *Epidesmia* and placed *Phrataria replicataria* Walker, 1866 (Fig. 17) and *Phrataria transcissata* Walker, 1863 into *Epidesmia.* This was followed by L.B. Prout, 1910 with the following note "*A not very compact genus, which would possibly bear subdivision according to the form of hindwing (*Epidesmia *with apex strongly produced,* Phrataria *with apex normal), the character of the frons, the size of the « basal cell » of the hindwing, etc*". Prout (1915) in Seitz (1915) (*Die Groß Schmetterlinge der Erde* vol 12) again placed these species in *Epidesmia.* Turner (1929b) followed suit and placed *Darantasia pachygramma* Lower, 1893b (now *Aglossophanes pachygramma*) into *Epidesmia* noting "*This little species is not near any other. Its appearance suggests a* Bichromodes, *but it has the neuration of* Epidesinia. *Its generic location cannot be definitely fixed in the absence of the ♂*".



Figs 1, 2. *Epidesmia tricolor*, **Figs 3–5.** *E. chilonaria*, **Figs 6–7.** *E. tryxaria* ♂,♀, **Fig 8.** Palps *tryxaria* left [verso] and centre [recto], *perfabricata* right [recto], **Fig. 9–11.** *E. hypenaria*, **Fig. 12.** *E. perfabricata*, **Fig. 13.** *E. reservata*, **Fig. 14.** *E. oxyderces*, **Fig. 15.** *E. brachygrammella*, **Fig. 16.** *E. phoenicina*, **Fig. 17.** *Phrataria replicataria*

Turner (1944) wrote "*Westwood* (*1841*) *made the genus* Epidesmia *for* tricolor; *Walker* (*1862*) *made* Plvrataria *for* replicataria; *Meyrick* (*1890*c) *sank Walker's genus to* Epidesmia, *and at the same time described* Satraparchis *for* bijugata (a species named by Walker under the genus *Panagra*), *overlooking the fact that these species agreed in neuration. The genus* Phrataria *must be restored. It differs from* Epidesmia *essentially in the stalking of 3 and 4 of the forewings, and contains* replicataria *Wlk.*, transcissata *Wlk., bijugata Wlk. and the following species.*" Turner went on to name *Phrataria V*-*album*. *Phrataria* stands today, and contains the four species, as mentioned herein.

In preparing this article I am indebted to E. Beaver, for information and images Figs 10 and 15; to W. Jenkinson, for information and images Figs 13 and 14; and to J. Moss, for information and access to his collection.

Glossary of terms

[1] Pectinated: Comb like
[2] Filiform: Thread like
[3] Termen: Outer edge of the wing
[4] Post medial line: Past the middle towards the outer edge
[5] Anal angle: The angle between the inner and outer edge of any wing
[6] at one forth: Measured from the base of the wing (where the base joins the thorax) one forth the length of the wing.
[7] Inner margin or dorsum: Lower margin of the wing
[8] Costa: Front of top edge of the wing

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Invertebrates: Who needs them?

(Transcript of presentation at the BCC Brisbane Biodiversity Seminar, Karawatha Forest Discovery Centre, Karawatha Forest Park. 14 September 2021)

Trevor A. Lambkin

Our Animal Kingdom comprises two main groups, the vertebrates and the invertebrates. The vertebrate group, which comprise larger animals such as mammals and reptiles which have an internal skeleton, immediately come to mind to most people. What are often not considered as animals, are the smaller creatures, the invertebrates, which mainly comprise the arthropods, and of these, most are insects. The invertebrates have an external skeleton and thus generally have no external soft tissues. In this presentation I look at the diversity of invertebrates, its significance and how might we interpret and protect our invertebrate diversity in Brisbane.

When assessing the diversity of invertebrates, it becomes clear that there are so many species, they are mainly small (Fig. 1) and there are generally so many individuals of each species. Why are there so many? Why there are so many is perhaps because the world needs that many to function and exist. The groups with the greatest number of individuals are the ants, termites, flies (Fig. 2), mites and spiders (Fig. 3).

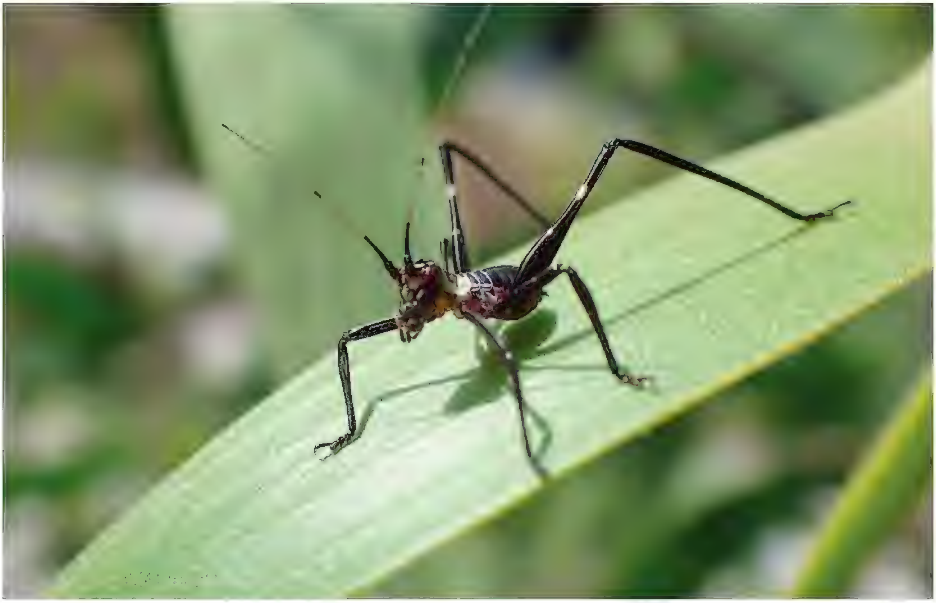


Fig. 1. Ant mimicking katydid

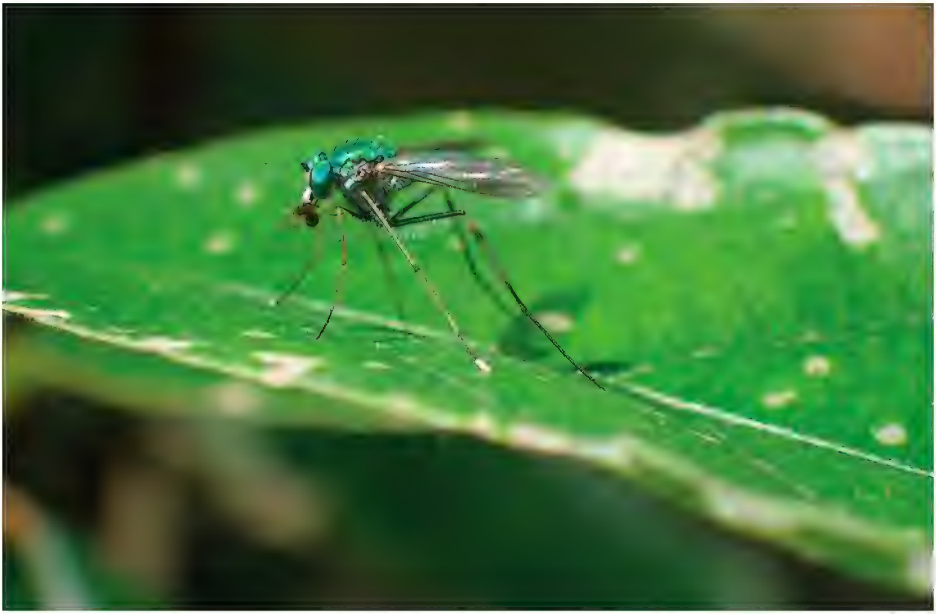


Fig. 2. Stilt legged fly

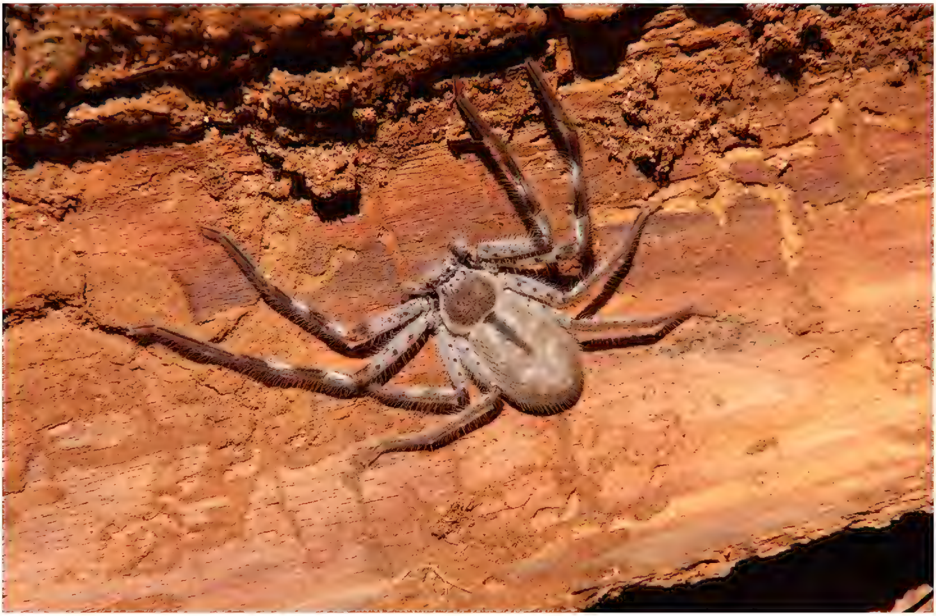


Fig. 3. Huntsman spider

To put this into perspective, let us consider some facts. We share the Earth with an estimated one quadrillion ants, that's 1,000,000,000,000,000 with more than 12,000 described species worldwide. There are roughly two million spiders per hectare of land, with about 45,000 described species globally. Termites annually inflict more than $5 billion worth of property damage in the United States alone, with around 2300 described species worldwide. Moreover, for each person on earth there are 17 million flies with approximately 150,000 described species worldwide.

Modest global estimates of invertebrate diversity indicate that there are around 10 to 15 million species, and it is likely that we have named only about 10 to 30% of these with many other unnamed species housed in the accessions of museums and herbaria. Overall, by far the most successful group in diversity of species and in sheer numbers is the insects (Fig. 4).

Within the insects, the greatest diversity of species are beetles (Order Coleoptera). There are 75 times as many beetles as there are mammals, and currently there are approximately 420,000 named species of beetle worldwide, and in Australia we have around 23,000 described species (Fig. 5). Estimates of the total number of beetle species worldwide are around 1.5 million species. In Australia, estimates of total number of species of beetle vary but the true number of species may be as high as 80,000–100,000. In the early 20th Century, the British scientist J. B. S. Haldane was asked: 'What could be inferred about the work of the Creator from a study of His works?' To this he was reported to say, 'An inordinate fondness of beetles'. Quite correctly, we live in an age of beetles as they are spread all over the world in such a diversity.

With such a level of diversity how can we measure the invertebrate diversity in Brisbane and monitor its health over time? Perhaps a method to relatively measure this diversity is to use a flagship group of animals, such as butterflies. The insects we know the most about are butterflies and they may be used as excellent barometers to indicate to us the relative health of ecosystems and a comparative measure of invertebrate diversity. Butterflies are mostly easy to sample and identify and the group is very popular with professional and amateur naturalists (Fig. 6).

Butterflies form an important part of the food chain and they are directly linked to plant species and other invertebrates and all of these are directly connected to the environment. A healthy intact environment leads to plant diversity which leads to a diversity of invertebrates to a diversity of butterflies. Thus, our butterflies are a window to our natural environment

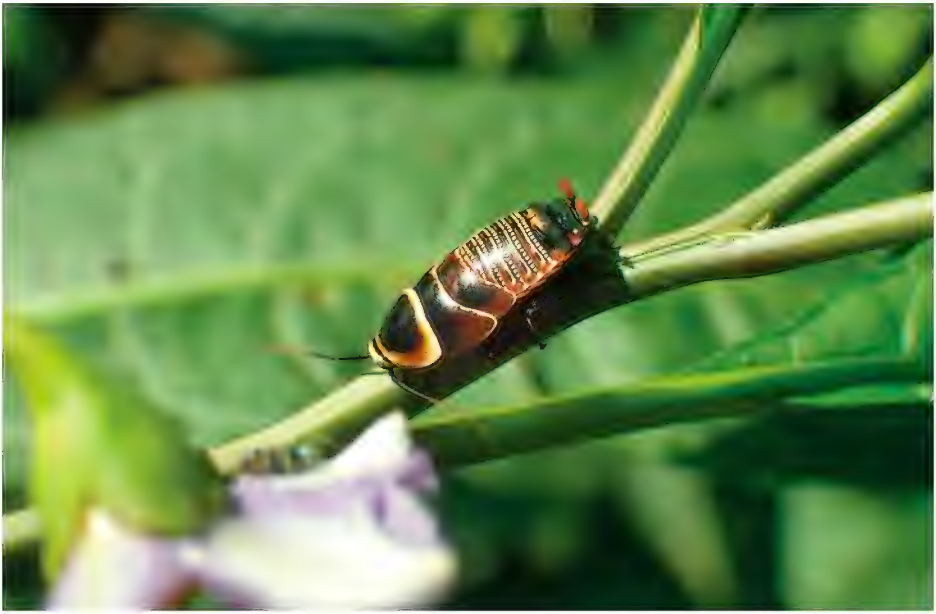


Fig. 4. Bush cockroach

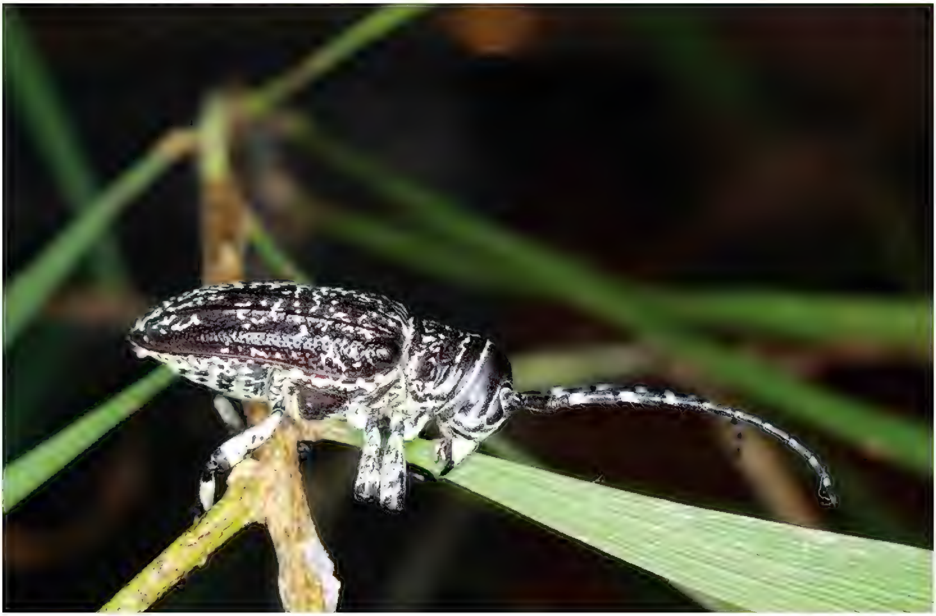


Fig. 5. Longhorn beetle (*Rhytiphora* sp.)

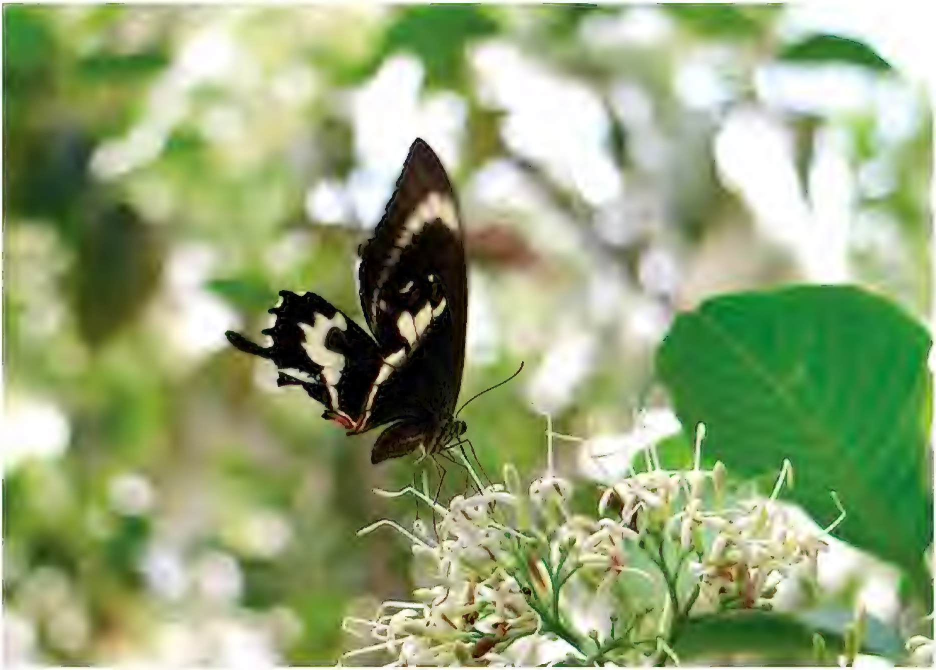
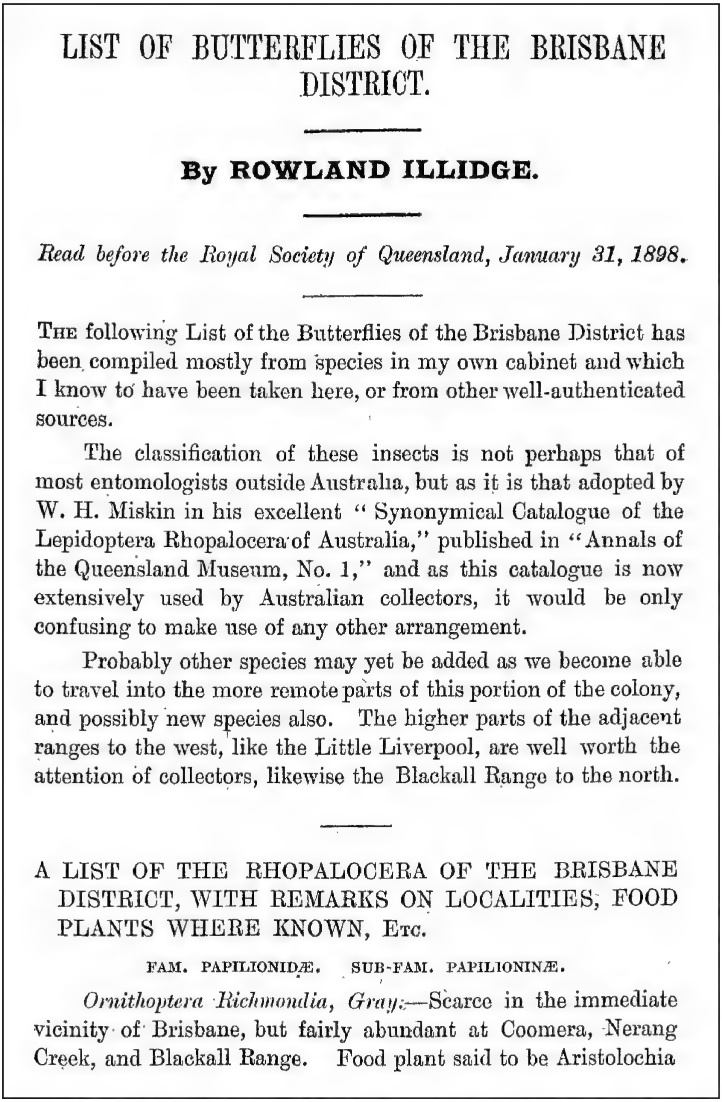


Fig. 6. Fuscous swallowtail (*Papilio fuscus*)

As with many environments, the biodiversity of Brisbane occurs in three categories of habitat, urban areas, revegetated zones, and reserves and virgin bushland. The major concerns for these Brisbane habitats, as for most habitats in Australia, are the effects of land clearing and weed invasion. In the larger Brisbane area coastal wetlands have all but disappeared and ground cover vegetation in remaining forest reserves are severely compromised due to invasive weeds.

One of the key principles of preserving our invertebrate biodiversity is knowing our biodiversity, and with butterflies acting as a key flagship species, knowing our butterfly diversity in Brisbane is a good start to assessing the health of our environment. Thus, a good start is to determine a baseline by surveying and monitoring our butterflies in Brisbane. This has been done several times prior with the first report of such a survey being published by Rowland Illidge in 1898 (Fig. 7). Comparing our recent data compiled last year during the time of Brisbane's Big Butterfly Count (BBBC) (i.e. between 90 and 100 species) to those of Illidge 120 years earlier, it seems that the Brisbane area has lost 24 species of butterfly in the last 120 years. The bulk of these species were restricted to riparian rainforest and wetlands (Fig. 8).



LIST OF BUTTERFLIES OF THE BRISBANE DISTRICT.

By ROWLAND ILLIDGE.

Read before the Royal Society of Queensland, January 31, 1898.

The following List of the Butterflies of the Brisbane District has been compiled mostly from species in my own cabinet and which I know to have been taken here, or from other well-authenticated sources.

The classification of these insects is not perhaps that of most entomologists outside Australia, but as it is that adopted by W. H. Miskin in his excellent "Synonymical Catalogue of the Lepidoptera Rhopalocera of Australia," published in "Annals of the Queensland Museum, No. 1," and as this catalogue is now extensively used by Australian collectors, it would be only confusing to make use of any other arrangement.

Probably other species may yet be added as we become able to travel into the more remote parts of this portion of the colony, and possibly new species also. The higher parts of the adjacent ranges to the west, like the Little Liverpool, are well worth the attention of collectors, likewise the Blackall Range to the north.

A LIST OF THE RHOPALOCERA OF THE BRISBANE DISTRICT, WITH REMARKS ON LOCALITIES, FOOD PLANTS WHERE KNOWN, Etc.

FAM. PAPILIONIDÆ. SUB-FAM. PAPILIONINÆ.

Ornithoptera Richmondia, Gray:—Scarce in the immediate vicinity of Brisbane, but fairly abundant at Coomera, Nerang Creek, and Blackall Range. Food plant said to be Aristolochia

Fig. 7. *List of Butterflies of the Brisbane District*: R. Illidge (1898)

So, what can be done to preserve our existing biodiversity? Firstly, we must appreciate that invertebrates hold our world up, and we owe the invertebrates much, as they are critical in the function of our planet. Thus, we all must be good stewards of our planet by preserving our environment and all its myriad of invertebrates. Secondly, we all must take the preservation of our invertebrate fauna seriously.

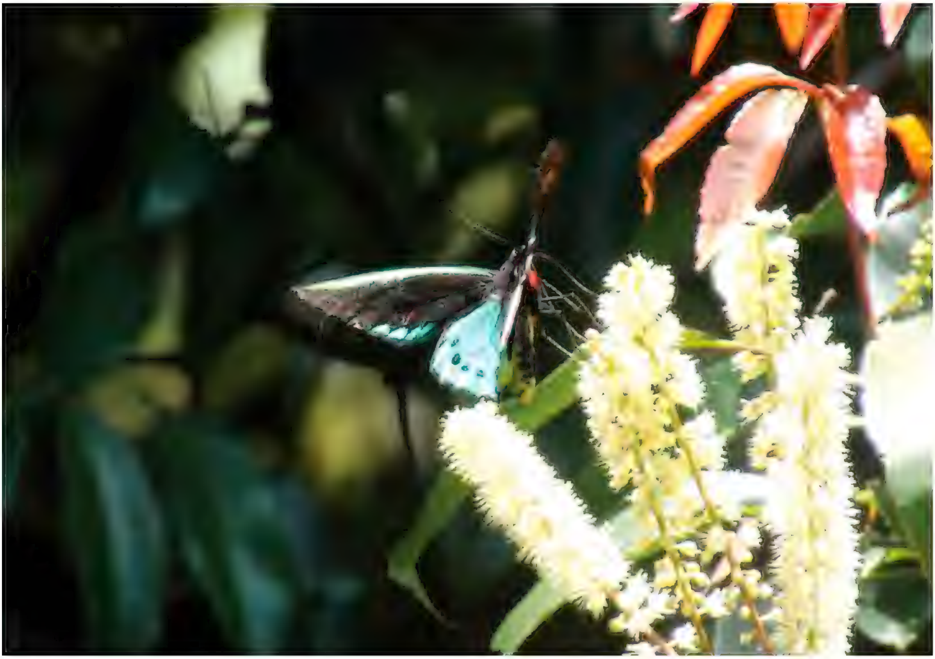


Fig. 8. Richmond birdwing (*Ornithoptera richmondia*)

We are fortunate in Brisbane to have several locally based groups (Butterfly and Other Invertebrates Club, Queensland Entomological Society and Brisbane's Big Butterfly Count) that are dedicated to knowing, studying and preserving our invertebrate fauna and we should lean on these groups strongly to gain a better understanding of our invertebrate fauna.

Having shown that our butterfly fauna is poorer than it was 120 years ago, it might seem inappropriate to suggest that collecting invertebrates should be encouraged. I am firmly of the belief that collecting is, in itself, a conservation measure. Collecting insects fosters an appreciation of the beauty of these creatures and leads to their understanding and their ways. From young collectors, entomologists are born and almost all our knowledge of invertebrates comes from their collection and subsequent study.

Finally, raising the awareness and profile of invertebrates is so very important for our planet. Assisting in surveys of this flagship group will directly lead to awareness of our environment and all of this will contribute to the preservation of our environment and its invertebrates. This will assist in us living in a green, healthy and life-filled city.

Biological control of the Spotted Alfalfa Aphid, *Therioaphis maculata* (Bucton), in Australia

Bernie Franzmann

I recently presented, on the topic of beneficial insects, to the BOIC. Traditionally, the speaker provides a summary outline of the talk in this magazine.

My talk principally covered ladybirds, lacewings, hoverflies, predatory bugs, and parasitic flies and wasps. I also discussed Australia's involvement in the first successful use of an insect to control an insect pest viz. the Australian ladybird, *Novius cardinalis,* for control of Cottony Cushion Scale in California, in 1888, and the first successful use of an insect to control a weed pest viz. importation of the moth, *Cactoblastis cactorum* from Argentina, in 1925, to control Prickly Pear in Australia.

I have published articles on ladybirds and lacewings in previous editions of this magazine and there is a wealth of information about *Novius* and *Cactoblastis* on the internet.

Therefore, I decided I would tell you about a successful biocontrol project I was involved in: the biological control of the Spotted Alfalfa Aphid, *Therioaphis maculata,* in Australia.

I was doing some work at the DPI Gatton Reasearch Station on March 29th 1977, when I saw an aphid which I had not seen before. There were a lot of them, infesting burr medic, *Medicago polymorpha.* The aphid had a very distinctive appearance with many spots. I remember thinking for a while, until I was struck – could it be?! I knew of an iconic aphid, a major pest of lucerne, *Medicago sativa,* in the USA; the Spotted Alfalfa Aphid (SAA). During my University studies the management of this pest in California, was taught as example of the relatively new idea (Integrated Pest Management), of not just relying on the routine application of pesticides for pest control but using all available strategies such as cultural control and biological control, combined with assessment of the economic impact of various strategies. SAA inherited its common name 'alfalfa' from the USA, where lucerne is known as alfalfa.

The pieces fitted. This was before the internet so I couldn't look up images. I drove back to my office in Toowoomba, stopping along the way to inspect some lucerne fields and, alarmingly, there they were in large numbers.

It was known that SAA was a very serious pest of lucerne in the USA. Aphids suck fluid from the phloem cells. Phloem is the tissue that conducts food, made in the leaves, to other parts of the plant. If there are a lot of aphids on a plant the plant may die of starvation. However, SAA also injects a toxin which has a detrimental effect on the plant. It also produces tremendous amounts of sticky honeydew which can clog harvesting machinery. Also, mould growing on this honeydew reduces livestock acceptance of the lucerne.

We immediately alerted people in the CSIRO and other State Departments. Entomologists across the country swung into action, inspecting lucerne paddocks. Aphids can spread very rapidly on wind currents. We found that, within two months, SAA had spread through New South Wales and Victoria and had reached South Australia.

Infestations built up very rapidly. These aphids are all females; they don't lay eggs but produce living young, at about the rate of one every six hours. In as little time as one week, newly-produced young become mature and reproductive. We estimated that, within a few weeks, some infested fields had at least one billion aphids per hectare.

We knew a lot about SAA and the possibility of biological control from a historical, American experience.

The aphid arrived in California in 1954, and went on a damaging rampage. They imported a few different species of parasitoid wasps. The one that was very successful was *Trioxys complanatus*, which came from the Mediterranean and Middle-East region.

T. complanatus parasitizes the aphid by injecting an egg into the body (Fig. 1). The wasp larva consumes the internal organs of the aphid and when the larva is ready to pupate, the aphid "skin" becomes hard, forming a "mummy". The wasp pupates inside the mummy and when the adult wasp emerges from the pupa, it cuts a hole and emerges from the mummy. SAA are the only aphids that *T. complanatus* parasitizes.

Co-ordinated by the CSIRO, Australia imported three different parasitoid species, including *T. complanatus*, in July 1977. This very quick response, in approving the introductions, is probably a record. After building up numbers, in protected environment enclosures, field releases began in October.

It soon became apparent that it was a spectacular success.

During autumn of 1978, we were recording up to 38% parasitism in lucerne areas in Queensland.

After its first discovery and before *Trioxys* populations had built up sufficiently, SAA had twice completely defoliated almost every lucerne paddock in Australia. It caused millions of dollars damage in the first year. Within six years the pest ceased to be an economic problem. Currently, it is a difficult task to find SAA in lucerne fields in Australia.

When the subject of importation of biocontrol agents is discussed, we often hear about the debacle of the cane toad, but the public rarely hears about successes, such as this one.

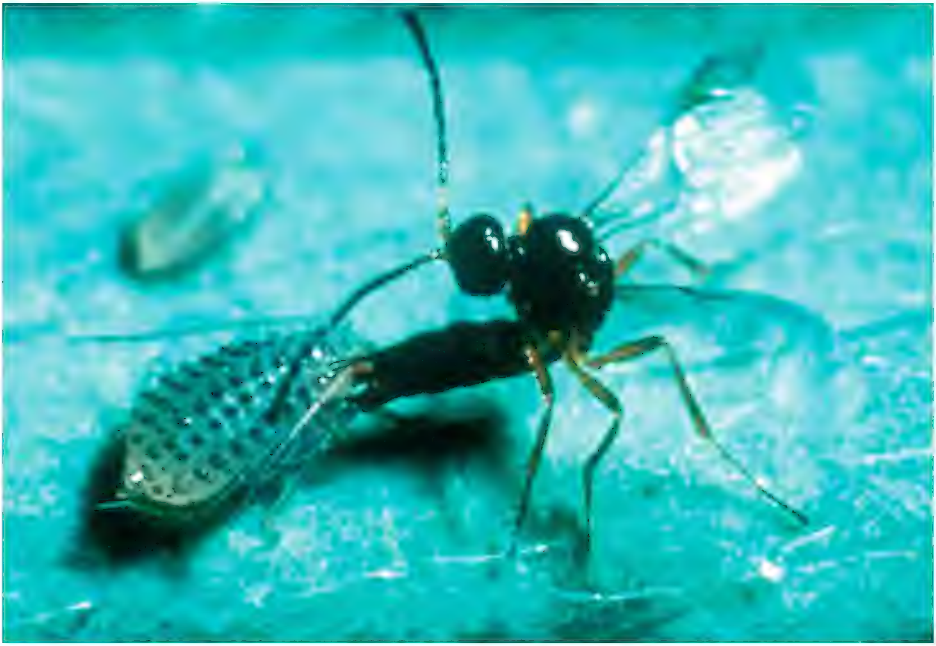


Fig. 1. *Trioxys* "stinging" a Spotted Alfalfa Aphid – CSIRO

Butterfly & Other Invertebrates Club Inc. (BOIC), Butterfly Survey, Boondall Wetlands, Brisbane Saturday 11 September 2021

Dawn Franzmann

The first of our butterfly and other invertebrates' surveys was held on the 11 September at the Boondall Wetlands. Twenty (20) BOIC club members were present. The weather was perfect for walking for taking in the beauty of the area. We were welcomed by Natalie Costanzo and Brodie McMahon from the Environment Centre's staff. It was lovely to meet a couple of our new members and to welcome again some long-time members of BOIC.

The Brisbane City Council has granted BOIC a permit to conduct surveys in their environment parks for the next twelve months. Trevor Lambkin and Russel Denton were our leaders and we proceeded along the Nurri Millem Totem Trail with lots of hope and anticipation that we were going to see butterflies in flight. This Totem Trail is in recognition of the original indigenous inhabitants of this area.

Not to be disappointed, we soon swooped with our nets, collected in our bottles and were able to identify a Dingy Ringlet, *Hypocysta pseudirius.* (Fig. 1). A few days prior, I had visited the same spot and I was pleased to have identified a Brown Ringlet, *H. metirius.* I had mentioned this to Trevor and I was excited to guide him to the spot when he quickly corrected my identification; I had seen a Dingy Ringlet, this was a welcomed surprise.

It was hard to keep the group together as everyone was keen to keep going in the search for a beautiful specimen they may not have seen before. A few members were keen to walk through parts of the mangrove section in search of the illusive Illidges's Ant Blue, *Acrodipsas illidgei.* This particular endangered butterfly is endemic to Australia and is found in mangrove areas.

Along the way we noticed other butterflies: Glasswings, *Acraea andromacha*, (Fig. 2), Blue Tigers, *Tirumala hamata*, Clearwing Swallowtails, *Cressida cressida*, Varied Eggflys, *Hypolimnas bolina*, Large Grass Yellows, *Eurema hecabe* (Fig. 5), Grass Dart, *Ocybadistes walkeri*, (Fig. 6). The most significant and exciting finds were to be at the end of our walk, when we netted a Satin Azure, *Ogyris amaryllis* (Fig. 3) and a Samphire Blue, *Theclinesthes sulpitius*, (Fig. 4).

It was certainly challenging to capture images of butterflies in the indentification bottles; however, our members were up to the challenge. Thank you to all members who submitted photographs.

Please read in the following list all of the butterflies we accurately identified.

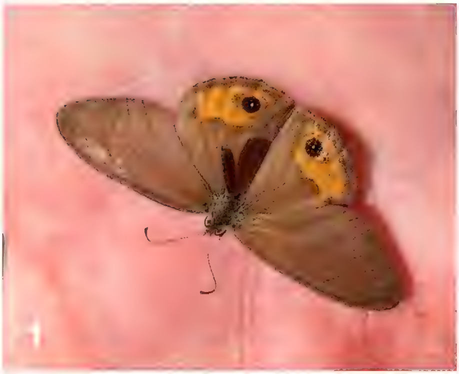
With summer, fast approaching we are looking forward to officially revisiting Boondall Wetlands for a further two surveys. The data that we record in our summer surveys will be included in the official records of Brisbane's Big Butterfly Count.

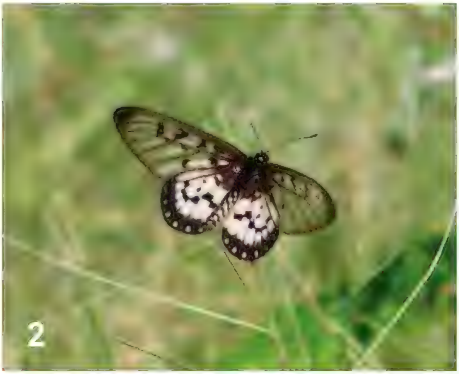
BUTTERFLY & OTHER INVERTEBRATES CLUB Inc.
2021/2022 SUMMER BUTTERFLY SURVEY NO. 1
BOONDALL WETLANDS – 11 SEPTEMBER 2021

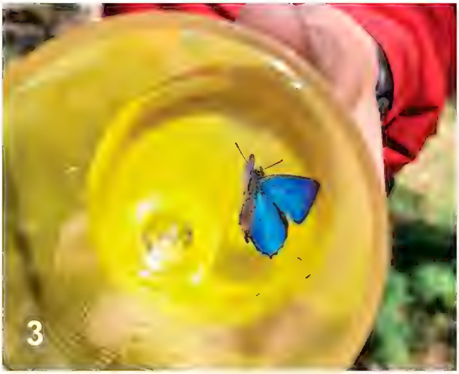
(DATA TO BE INCLUDED IN THE BRISBANE'S BIG BUTTERFLY COUNT)

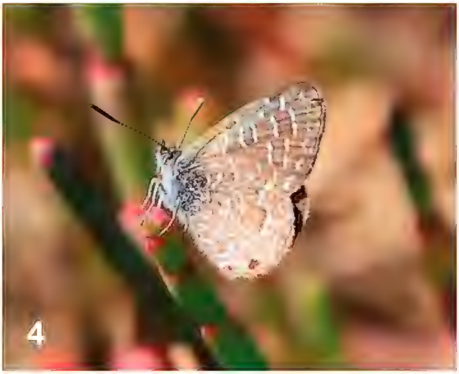
Common Name/Butterfly	**Scientific Name/Butterfly**	**Nurri Millen Totem Trail & Part of the Mangrove Section**
Lemon Migrant	*Catopsilia pomona*	Collected, identified and released between the hours of 10.30 am and 1.00 pm.
Dingy Ringlet	*Hypocysta pseudirius*	
Glasswing	*Acraea andromacha*	
Small Dusky Blue	*Erina erina*	
Common Crow	*Euploea corinna*	
Black Jezebel	*Delias nigrina*	
Common/varied Eggfly	*Hypolimnas bolina*	
Clearwing Swallowtail	*Cressida cressida*	
Wanderer/Monarch	*Danaus plexippus*	
Large Grass Yellow	*Eurema hecabe*	
Swamp Tiger	*Danaus affinis*	
Evening Brown	*Melanitis leda*	
Satin Azure	*Ogyris amaryllis*	
Samphire Blue	*Theclinesthes sulpitius*	
Saltbush Blue	*Theclinesthes serpentatus*	
Green Grass Dart	*Ocybadistes walkeri*	
Large Dark Grass Dart	*Suniana sunias*	
Blue Tiger	*Tirumala hamata*	

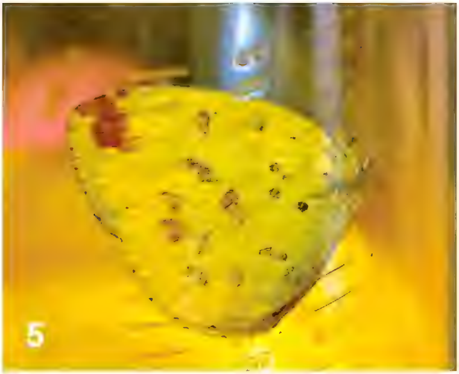
Trevor Lambkin and Dawn Franzmann,
Recorders











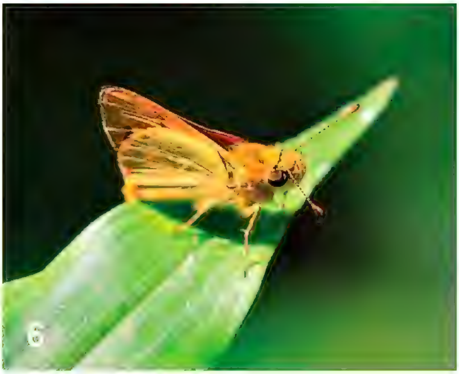
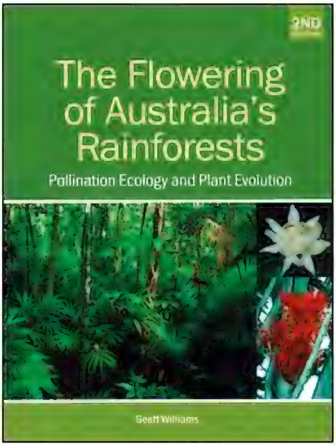


Fig. 1. Dingy Ringlet, *Hypocysta pseudirius*, © Jack Wade
Fig. 2. Glasswing, *Acraea andromacha*, © Jack Wade
Fig. 3. Satin Azure, *Ogyris amaryllis*, © Ian Ferrier
Fig. 4. Samphire Blue, *Theclinesthes sulpitius*, © Deanne Gaskill
Fig. 5. Grass Yellow, *Eurema hecabe*, © Rip Curtis
Fig. 6. Grass Dart, *Ocybadistes walkeri*, © Deanne Gaskill

The Flowering of Australia's Rainforests: Pollination Ecology and Plant Evolution, 2nd Edition, by Geoff Williams

CSIRO Publishing, Clayton South, xii + 276 pp.

Reviewed by Roger Kitching


2ND
The Flowering of Australia's Rainforests
Pollination Ecology and Plant Evolution
Geoff Williams

This is the fourth major work to be authored (or co-authored) by Geoff Williams, an Honorary Research Associate at the Australian Museum, Sydney. The first of these was *Hidden Rainforests: Subtropical Rainforests and their Invertebrate Biodiversity* (Williams 1993). This was followed by the first edition of the book currently being reviewed (Williams and Adam, 2010). Then, in 2020, he authored *The Invertebrate World of Australia's Subtropical Rainforests* (Williams, 2020) and now, merely a year later, the current volume has appeared, authored by Williams alone. The current volume, then, expands Williams' usual focus on subtropical rainforest to summarise and collate work on all those ecosystems defined as 'rainforest' in Australia (where the accepted definition is a very broad one) plus results from adjacent ecosystems containing rainforest 'elements'. It gathers up and reviews the large amount of work carried out between 2010 and the present and, as such, represents a very up-to-date account of the pollination dynamics of Australia's richest ecosystems.

It should be said at the outset that this work is very much an ecological monograph and, as such, succeeds well, but this does mean that the non-specialist will need to delve deep and persevere to appreciate it's many lessons. For the general naturalist in Australia, though, it provides approachable accounts of plant history, evolution and biogeography as well as the gradual development of the animal/plant interactions that, ultimately, have marked the success of the flowering plants. For the invertebrate specialist it holds a great deal of interest because, as animal/plant pollination systems evolved, it was the invertebrates (and the insects in particular) that were the major players in tight interactions with the plants. Of course, pollination by vertebrates is common in Australia as evidenced by the robust inflorescences of many Proteaceae and Myrtaceae in our woodlands, but these interactions are mostly outside the rainforests (with the exception of the actions of tropical blossom bats in northern rainforests).

Let me, then, highlight a few parts of the book and its subject matter that I found particularly interesting and useful.

First, the earlier Chapters provide a summary of the evolution of the vascular plants in general (that is; everything from the ferns onwards) and the seed-bearing groups in particular. The focus is on the current and fossil Australian flora and these two introductory Chapters will provide a foundation and framework for anyone interested in but perhaps bewildered by the current diversity of our flora. Animal/ plant interactions leading to pollination probably started (and continue) within the cycads but it was the true flowering plants, the angiosperms, originating in the late Jurassic and early Cretaceous, that really exploited and co-diversified with their pollinators – principally insects. Many of the plant families we now think of as close to the first flowering plants are found in northern Australia and the South Pacific suggesting an original diversification somewhere in our neighbourhood.

A central section of Williams' book focuses on the rainforest environment itself. One of the defining features of rainforest is the sheer diversity of tree (and other plant) species which make up any small part of it. By way of example let me quote some of results that my research group generated over the years (figures from Laidlaw, 1999). In a one-hectare plot at Lamington National Park we encountered 76 woody species with stems more than 5 cm diameter at breast height. A comparable count for the Atherton Tableland showed 113 species (and for lowland forest in Brunei, Borneo, a huge 279 species). This sheer richness presents issues for pollination and, perhaps, leads to a preponderance of generalist pollination situations were a whole range of pollinating insects (and even vertebrates) may act to transfer pollen among the scattered individuals of a particular tree. Of course, this doesn't mean a whole set of the highly specialized interactions so beloved of naturalists (and natural history film makers) do not occur just that the canopy trees in particular may be much less fussy in their sexual habits.

The final part of Williams' book contains two sections on the nitty-gritty of pollination and, as such, should well satisfy those fascinated by the very specific interactions that have been recorded. Chapter 8 looks at the whole range of pollination events based on who's doing the pollinating – from beetles ('cantharophily') to reptiles ('saurophily'). Then an Appendix presents six well-worked case histories for particular plants or groups of plants – from *Pollia* on the forest floor to *Alphitonia* in the canopy.

Rainforest conservation and, in particular, restoration demands, as Williams points out, that we preserve the plant species which occur within the remnant forests. This is not, however, enough. We must, as far as we can, conserve equally the ecological interactions which engage the plant species with each other and with the myriad of, particularly invertebrate, species, which are equally characteristic of these forests.

A concern for, deep knowledge of, and focus on the pollination mechanisms of our rainforests is therefore essential if we are to make sensible on-going management decisions. *The Flowering of Australia's Rainforests* gathers together virtually all of our current knowledge in this area, places that knowledge into its evolutionary and ecological contexts, and, by so doing, provides us with a vital handbook for looking after our richest ecosystems into the future.

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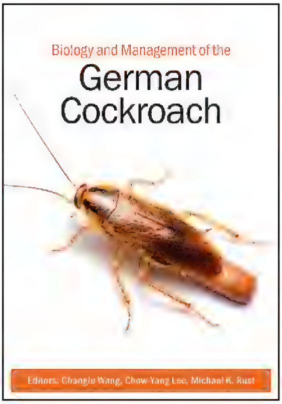
Amata sp. (Erebidae–Arctiinae) feeding on *Acronychia oblongifolia*

Biology and Management of the German Cockroach, by Changlu Wang, Chow-Yang Lee and Micheal Rust. 2021

CSIRO Publishing & CABI, Hardback, 320pp RRP: AU $220.00

Reviewed by Myron (Meron) P. Zalucki


Biology and Management of the
German Cockroach
Editors: Changlu Wang, Chow-Yang Lee, Michael K. Rust

The advertising blurb says, “Comprehensive reference on the biology, behaviour and management of German cockroaches” and it is not wide of the mark. This is one of those “everything you ever wanted to know about but were too afraid to ask” sort of books, and yes there is an extensive treatment of sex (in cockroaches), with apologies to Woody Allen.

It is an edited volume with 13 chapters and 14 contributors. For such a cosmopolitan pest it was a tad surprising that all the authors are based in the USA, but they are all major contributors to research on a problematic insect that is part and parcel of our daily lives! German cockroaches have never been found in natural habitats it seems, they have effectively adopted us much like dogs did. Alas we spend many billions each year trying to rid ourselves of this fellow traveller!

An inkling of the comprehensive coverage can be gleaned by viewing the chapter titles. The first two set the scene and importance of the species to our potential lack of wellbeing (1. “German cockroach infestations in the world and their social and economic impacts”; 2. “Public health and veterinary importance”), next come five chapters on biology, behaviour and ecology (3. “Biology, nutrition and physiology”; 4. “Rearing German cockroaches for research”; 5. “Endosymbionts and the gut microbiome”; 6. “Behaviour and chemical ecology”; 7. “Dispersal and population genetics”) and finally six on management (8. “Monitoring”; 9. “Chemical control methods”; 10. “Management using baits”; 11. “Insecticide resistance: perspectives on evolution, monitoring, mechanisms and management”; 12. “Alternative control measures”; 13. “Management in multi-unit dwellings and commercial kitchens”).

If you are struggling with the titles do not shy away. The book is a good read. The comprehensive coverage may suggest we know all there is to know in what has become a “model organism” in biology. Yes, we do know a great deal, but all the chapters cogently point out that gaps remain. The target audience I suspect are so called pest managers, and those looking to get into the field; nascent researchers

(PhD students). Given the state of universities these days the book (yes, it is a book not a Web "resource") is probably beyond most undergraduates: too many words, no abstract at the start of each chapter and not enough colour pictures! There are only 18 colour plates.

Interestingly, although over 100 potentially pathogenic bacteria have been isolated and cultured from German cockroaches collected from various habitats (farms, homes, hospitals, hotels, markets, restaurants, and zoos), many with resistance to a wide range of antibiotics, "there are no studies showing a clear epidemiological relationship between cockroaches and infectious disease in real world settings". There is however good linkage between cockroaches as source of inhalant allergens and as major causes of asthma morbidity. If that has piqued your interest read chapter 2.

A few brickbats and bouquets and to show I read the book! The first scene-setting chapters covers the occurrence of the species. There are sections on North America (equals the USA), Europe, Asia and briefly Africa. Oddly enough Oceania and South America are left out and in the case of Australia probably reflects the dearth of published work on these pests.

One thing I find annoying is the redundant use of "family" as in the following sentence in Chapter 3: "German cockroaches are the most well-known… of the family Ectobiidae…". The ending -idea denotes a family name so family is redundant. That is me just being pedantic. My other pet hate is entomologists citing how long it takes different life-history stages to complete development in days without specifying temperature (page 54, under life cycle). That aside the chapter on Biology draws on work on related species, as indeed not everything is known about German cockroaches.

Endosymbionts and the gut microbiome have become a hot area of research in entomology, particularly in the last 10 years. Species of a gram-negative bacterial endosymbionts in the genus *Blattabacterium* are transmitted from mother to offspring in all cockroaches except cave-dwelling species, and are essential for growth and reproduction. In addition, the gut contains a complex microbiome, passed on by coprophagy (yes eating faeces), that has effects on behaviour and physiology (Chapter 5). The field is really in its infancy, and we are a long way from unravelling the interaction between microbes and the animals that host them – including in ourselves.

I personally found the chapter on behaviour and chemical ecology enlightening: it is a story of very specific chemical compounds that mediate behaviour – from aggregation (links nicely to the previous chapter on gut microbiome), to kin-recognition, mate recognition, courtship and copulation – it is all about odours and chemicals in the cuticle and various glandular secretions. Identifying the specific compounds, how and where they are detected and how they effect behaviour should be mandatory reading for undergraduates interested in sex (in animals). As the authors note all the behaviours of cockroaches affect our attempts at management and yet there are no traps that use sex pheromones or the male tergal gland secretions! Again, many questions remain unanswered (see page 133) and could form the basis of promising careers in research!

The German cockroach is one of the few insects in which so called behavioural resistance to using sugar baits laced with insecticide has been shown, although many other cases have been claimed (see Zalucki & Furlong 2017). The mechanism involves heritable changes in the response of gustatory (taste) receptors to sugar, unlike other claims to behavioural resistance that probably relate to indirect and direct effects on "normal" behaviour via odours.

All the chapters on basic biology point to improving the management of the species by minimising populations. One of the crucial questions in all pest management is to determine where do these infesting population come from; what are the source populations of infestation? – genetic tools will be important here (Chapter 7). One of the keys to management is being able to monitor populations (Chapter 8). Interestingly there is a long way to go to getting reliable estimate of numbers. Yet all the chapters on management highlight the importance of monitoring. The take-home message is that some monitoring methods are better than none and traps are better than most other methods.

This book should be read by all the myriad of folk that claim to be managers of insects in Urban environments, so called pest management professionals (PMPs). From the chapters on management most PMPs, in the USA at least, are purveyors of chemical control. I suspect we are no different in Australia. The authors all point to the need for IPM – Integrated Pest Management. Within that broad church most folk still use chemicals because they can be effective (reviewed thoroughly in Chapter 9), but bait formulations are particularly effective and more environmentally friendly (reviewed in Chapter 10) both within individual residences and community wide programs (apartment complexes) (Chapter 13). The authors highlight that adjusting the number of baits based on monitoring led to more superior control results, but real IPM should entail the whole package: "trapping, vacuuming, sanitation, harbourage reduction, precision use of repellents", as well as "conventional insecticides, IGR's and elimination of cracks and crevices". Many residences have more insecticide residues than cockroachs.

Alternatives to insecticides are critically appraised in Chapter 13. Avoid snake oil merchants trying to sell ultrasonic devices. There is no conclusive evidence to suggest these contraptions are effective at repelling or killing cockroaches!

Perhaps one of the more subtle but telling comments concerning management was that sanitation is not a pre-requisite to effective management and indeed “poor sanitation” is often used by PMPs to apportion blame to residents for their own lack of competence! (Page 281).

Reference

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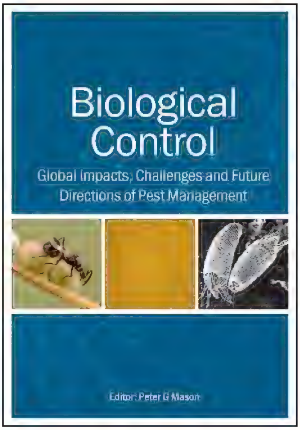
Biological Control – Global Impacts, Challengers and Future Directions of Pest Management – Editor: Peter G Mason

CSIRO Publishing

Reviewed by Bernie Franzmann


Biological Control
Global Impacts, Challenges and Future Directions of Pest Management
Editor: Peter G Mason

This is a weighty tome. The book provides a comprehensive global overview of biological control. Contributors come from all over the world, including five Australians, of whom four are from Queensland.

There are twenty-two (22) chapters, arranged under five sections.

History of Biological Control

This section describes the diversity of organisms used in biological control. Due to my background, I immediately think of control of pest insects and the use of insects as biocontrol agents. However, the book also covers everything else, such as the use of viruses, bacteria, fungi, nematodes, spiders, mites, and, yes, cane toads. It of course also covers the biocontrol of weeds, and even rabbits.

The main types are described; conservation, importation and augmentative biological control, and unintentional introductions.

Biological Control in the 21st Century

This section discusses the issues and challenges, confronting biological control, in the 21st century; benefits and risks, regulatory issues, access and benefit sharing, climate change and taxonomy.

For most of the 20th century, biological control agents were selected based on their killing power, with little or no emphasis placed on non-target attack on native or beneficial species. This general lack of concern has changed. The benefits of biological control must be assessed in the broad context of agricultural production, consumer concerns, economic interests and the conservation of natural habitats and biodiversity. Successful, importation biological control, can deliver immense economic benefits.

Australia is among many countries that have adopted legislation and/or policy to guide regulatory agencies on the introduction of imported biological control agents.

Since the beginnings of biological control, discovery, evaluation and implementation of biological control agents has relied on the principles of free use and exchange among providers and recipients The Convention on Biological Diversity is a legally binding international treaty, to which 196 countries, including Australia, are party.

There is growing concern that because climate change has been documented to cause range shifts and population changes, the distribution and effectiveness of biological control agents may be altered.

Without the correct scientific name for an organism, any communication about it is liable to be worthless, or worse, misleading. The most important new taxonomic tools over the past two decades are molecular techniques, which allow for accurate identification.

Socioeconomic Impacts of Biological Control

The issues discussed here are public perceptions, economic impacts and uptake.

In general, modern importation biological control, has been safe and beneficial. However public perceptions do not seem to mirror this success. Several valid important programs have been delayed or cancelled due to public pressure. There are various reasons for this, and discussed here, are six major cases where public perception has impacted biological control. Interesting examples, from pop culture, is a negative portrayal, in the television show, *The Simpsons* and a positive one, in Joni Mitchell's song, *Big Yellow Taxi*.

A chapter on the economic impact of biological control contains very complex models such as benefit-cost analysis and bioeconomic model and risk assessment. I don't know about how you might respond, but I skipped over this chapter.

The uptake of biological control, worldwide, is still limited compared with chemical control. Some of the reasons for this, such as, attitudes of the pesticide industry, farmers, government institutions and policy makers, are discussed.

Biological Control Successes and Failures

The successes and failures in different regions around the globe; Oceania, Africa, Eurasia, Indo-Pacific/Orient, North America and Latin America, are explored. Examples of case studies are documented and analyzed.

Future Prospects for Biological Control

This section proposes future directions for biological control, by better integrating pest management with it, viewing it as a conservation science and finally, moving the science to an evolutionary ecological scale.

References

Each chapter is backed up by an extensive reference list. Most references are accompanied by a Digital Object Identifier (DOI), which allows one to read the abstract of the article and, in many cases, read the whole article.

Conclusion

If you are a student, or even a biocontrol practitioner, this would be an essential book to have on the shelf. This would be your go-to book. It covers everything – the theory and the practice

The book aims to "provide a statement on the state of biological control and demonstrate that it is a truly global endeavour." I am sure it succeeds.

COVER IMAGE

Robber Fly, *Ommatius mackayi* Ricardo

I took the photo of this Robber Fly, *Ommatius mackayi* Ricardo, on our five-acre house block in Boonah, early morning, 18th March 2013. It is a female specimen. The species is found from northern Queensland to about Coffs Harbour. I was using a hand-held Pentax K-3 camera on automatic setting fitted with a Pentax FA Macro f2.8 lens. The block is densely planted with native trees and shrubs with a wonderful population of insects, including a number of predator species, including Robber Flies, Assassin Bugs, Wasps and Dragon Flies. At the time two of these were hunting from a Native Jasmine stem lookout, snapping small insect prey out of the air for an hour or more. (Aub Podlich)

GUIDELINES FOR AUTHORS

Text to be 11 font size Times New Roman with 1.5 times New Roman spacing. Images are to be a minimum of 300dpi, originals separate to the document and captions provided for each image. Adherance to the deadlines for submission would be greatly appreciated.

All articles/contributions to be submitted to the Editorial Committee at secretaryboic@gmail.com.

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